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AND

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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The net earnings of 131 railways for the month of May, 1892, show a decrease of 4.6% from those of the corresponding month last year, according to the "Financial Chronicle." The decrease is quite generally distributed through the country, and is attributed to the bad weather, a smaller grain movement and a generally heavy increase in operating expenses. Of the total 131 roads, 22 show decreases of over $40,000, and 14, gains of over $30,000. Several of the roads exhibit heavy decreases, notable among which are the Pennsylvania and Chicago, Burlington & Quincy systems, with decreases of $307,184 and $251,376, respectively. Four of the eight groups of roads, viz., the trunk lines, Middle and Northwestern States, and Pacific roads, exhibit decreases of 10.1%, 6.58%, 12%, 7.4%, respectively. The other five groups exhibit increases of from 0.84% in the Southern States to 8.1% in the Middle Western States. Gross earnings for the same month on the same number of roads show an increase of 3.65%.

A large rock cut and tunnel will be excavated by the New York, New Haven & Hartford R. R. Co. at Fair Haven, Conn., to do away with the numerous grade crossings in that town. The cut will be about one mile long and the tunnel 900 ft. long. The tunnel will be built for two tracks and will be 28 ft. wide and 20 ft. high. The material penetrated is solid rock and it is expected that it will take one year to complete the work.

The Board of Trade investigation into the wreck of the Inman Line steamer "City of Chicago" has resulted in the censure of the captain of the vessel as guilty of negligence. The court found, having regard for the fact that the weather was intermittent and the fog very thick at times, that the vessel set nearer the land than the master expected, and that the log-book showed that he was traveling faster than he calculated. The master was in default for not having used the lead with greater frequency, and for allowing his vessel to proceed at full speed upon a course approaching land at a time when the weather was not such as to justify such a proceeding. The court also found that the ship was properly equipped, and that everything was in good working order. The right measures were taken after the stranding of the "City of Chicago" to save the passengers and the ship. The vessel was wrecked off the Irish coast on July 2.

The U. S. cruiser "Columbia" (more popularly known hitherto as the "Pirate") was launched from the Cramp's ship yards at Philadelphia on July 26. She is one of the two sister ships designed expressly as commerce destroyers and will be one of the largest vessels of this class in the world. Her dimensions compared with those of five other leading modern cruisers were given in our issue of April 28, 1892.

The proposed new station for the Pennsylvania R. R. at Broad and Market Sts., Philadelphia, Pa., will be ten stories high, including the basement, and will cost about $1,250,000. The plans as prepared by the architects, Furness & Evans, provide for a frontage of 306 ft. on Broad St. and 212 ft. on Market St. The lower story will be of granite and the remainder of the building of brick, with terra cotta trimmings. The style of architecture will be modern gothic. It is expected that work will be begun within five or six weeks.

An incline railway is to be built to the summit of Mt. Nonotuck, Massachusetts, and it is stated that work will begin at once. The road will be built on the north end of the mountain and will be about one-half a mile long. It will be double tracked and operated by cables. Mr. Wm. Street, of Northampton, Mass., who owns a large hotel and pleasure resort on the mountain, is building the road.

The most serious railway accident of the week was a head collision, near Tamworth, Ont., on the Bay of Quinte Ry., July 21. A ballast train which had orders to pass a regular passenger train at the gravel pit was met by the passenger train before it had reached the gravel pit. Both engines and several cars were wrecked. Four persons were killed and four injured.

A bridge failure caused by cars derailed by a re r collision of freight trains, occurred at Connersville, Ind., July 15. Several cars were wrecked, but nobody was seriously injured. The bridge carries the Cincinnati, Hamilton & Dayton R. R. across the Whitewater River, and we are indebted to Mr. C. Wood, Chief Engineer, for the following particulars of the accident:

The bridge consists of three spans, each 165 ft. c. to c. of pins. It is a combination bridge of the Warren type, built in 1885. The two end spans were thrown down by the derailment of cars on them. A freight train standing on the bridge was struck in the rear by one descending a grade and beyond the control of its crew. The engine of the latter train lay within 60 ft. of the west abutment of the bridge. The west span fell to the north, and the east span fell to the south, presumably from the breaking out of some weak car of the train. The cars remaining standing on the center span were in a considerably damaged condition.

A plan to utilize the water power of the Ocmulgee River for furnishing the city of Macon, Ga., with electric lights and motive power has been prepared by a syndicate of capitalists, who will, it is stated, expend $150,000 in the proposed work. The plan provides for the construction of a dam of wood and stone across the river about eight miles above Macon, and the excavation of a canal 50 ft. wide and 8 ft. deep from the dam to the power station, one mile below. The power will be furnished by turbines of 600 HP. each. The projectors think that about 6,000 HP. can be furnished, and that electric motive power can be furnished to mills and factories at $5 per HP.

The telephone interest, according to Census Bulletin No. 196, has increased in the past ten years as follows:

	1880.	1890	Increase.
Number of companies reporting	148	53	(Dec.) 95
		$	$
Total investment	14,605,787	72,341,736	57,735,949
Gross earnings	3,098,081	16,404,583	13,306,502
Gross expenses	2,373,703	11,143,871	8,770,168
Net earnings	724,378	5,260,712	4,536,334
Number of exchanges	437	1,241	804
Number of telephones and transmitters	108,638	467,353	358,718
Miles of wire	34,305	240,412	206,107
Number of employees	3,338	8,645	5,307
Number of subscribers	48,414	227,357	178,943
Number of conversations		453,200,000	

The "gross expenses" doubtless include some very comfortable balances to stockholders.

A novel method of excavating for foundations in damp ground is mentioned by "Indian Engineering." A hole is bored about 1½ ins. diameter and 10 to 12 ft. deep, and charged with cartridges. These, when exploded, excavate a hole about 3 ft. in diameter, and drive the water out of the earth surrounding the hole to such a distance that it does not filter back for more than an hour, during which time the excavation is filled with quick setting concrete. By the time the moisture returns, the concrete is sufficiently hardened to resist the water.

One armored cruiser of 8,000 tons displacement, and one battleship of 9,000 tons is the extent of the additions to be made to the navy, according to the provisions of the Naval Appropriation bill, on which a joint conference committee has finally come to an agreement. The cost of the new battleship is not to exceed $4,000,000. Among the other items of the bill is an appropriation of $50,000 for the international naval review, in which is included the reproduction of fac-similes of two of the ships of Columbus' fleet.

The pumpage of water at Green Bay, Wis., is automatically recorded in the office of W. K. Harrington, Superintendent of the Green Bay & Fort Howard Water-Works Co., by means of a device which he invented. The piston of the pump is connected with a counter, which transmits an electric current to the office of the superintendent once in a given number of strokes. The number of strokes, as well as the pressure, is recorded by a pen on a movable chart.

Breadstuff exports (under which term is included all kinds of grain and flour), show the following unexampled aggregates for one, six and 12 months, ending June 30, 1892, in comparison with similar periods for the previous year:

	1 mo.	6 mos.	12 mos.
1892	$16,448,977	$132,935,807	$288,925,000
1891	13,199,536	68,350,307	124,156,520
Incr.	3,249,441	64,585,500	165,768,480

And yet, in spite of this notable increase, this is not a boom year, and coin tends to leave us rather than come this way.

The American Forestry Association, through a committee consisting of B. E. Fernow, Edward A. Bowers, and N. H. Egleston, has presented to the President a memorial from the Colorado Forestry Association asking him to withdraw from sale and entry all timber lands of the state on the mountain crests.

The Brooklyn Bridge Terminal Committee held a meeting last week, and after considerable discussion it was decided to adopt the plan which is to be submitted to the committee on Aug. 15 by the engineers of the Kings County Elevated R. R. and the Brooklyn Elevated R. R. and the Brooklyn Bridge railway.

A bill to enforce the use of automatic brakes and couplers has been prepared by the Senate Committee on Interstate Commerce. It provides that after Jan. 1, 1898, it shall be unlawful for any common carrier to use in interstate traffic by rail any locomotive that is not equipped with power or train brakes, or to run any train in such traffic that has not a sufficient number of cars so equipped as to permit the engineman to control its speed without requiring the application of hand brakes. After the same date, also, it shall be unlawful for any railway to haul or use in interstate traffic any car not equipped with couplers uniform in type and coupling automatically upon impact, and which can be uncoupled without the necessity for men going between the cars. The couplers are to be of the standard type used by such carriers controlling 75% of the cars used in such traffic, and the carriers are to report to the Interstate Commerce Commission within one year from the date of the passage of the act the standard type of couplers so used by them, and upon failure to do so the commission is to prescribe the standard. Any railway company guilty of violation of the act shall be fined $100 for each offense, and it is made the duty of the U. S. District Attorneys to bring the suits upon information filed.

A Water-Works Association to include representatives of works in Washington, Oregon and Idaho, is proposed. A meeting, at which the matter was discussed was held recently at the office of C. B. Hurley, Superintendent of the Tacoma (Wash.) Light & Water Co. Mr. Hurley together with Messrs. G. D. Rice, Sumner, Wash.; W. F. Newell, Olympia, Wash.; and T. W. Gillette, Fairhaven, Wash., were appointed a committee on organization.

Wrought iron pipe has been proposed at Chicago as a substitute for extending the intake tunnels of the water-works. The plan is evidently the same as, or similar to, the Powell system of laying submerged pipe, described and illustrated in Engineering News for March 19, 1892. By this method the pipe was to be put together in sections, towed to place, the sections joined and then the whole length of the pipe sunk to place at once.

The water of the Breslau water-works, taken from the Oder River, is examined quarterly as to its chemical composition and daily with a regard to the bacteria it contains. The "Gesundheits-Ingenieur" states that these daily examinations, which have been carried on for nearly two years, have demonstrated that the water usually contains a very low number of germs capable of development, not reaching the amount allowable for good drinking water. After storms, however, or when it is beginning to thaw, the number of germs in the conduits increase seriously, so that a meteorological change of that kind can always be told by a sudden rise in the number of germs, which the water carries. It is stated that there exists a constant ratio between the number of germs the drinking water contains and the transparency of the latter.

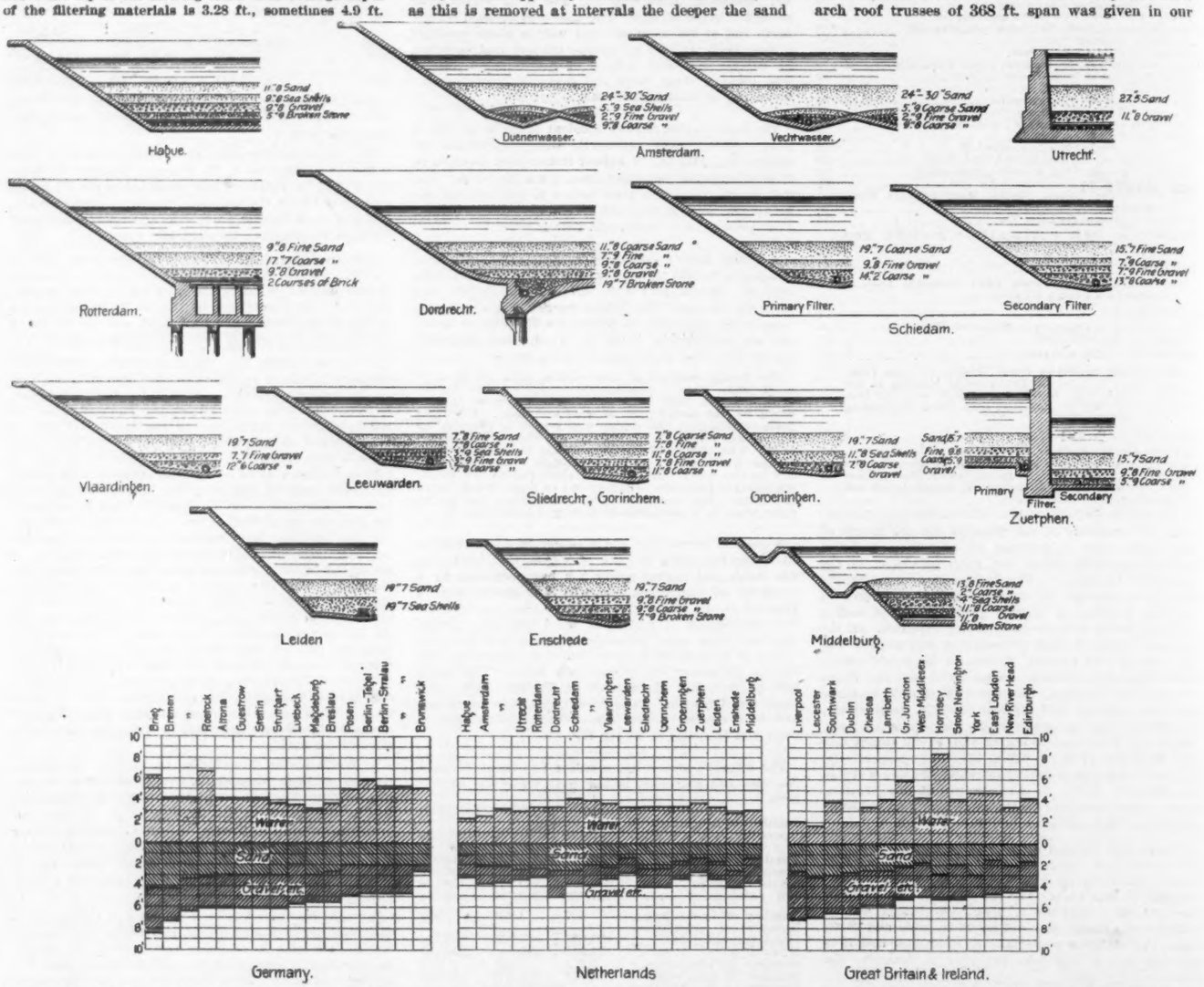
Cultures of the micro-organisms found demonstrated that they are entirely harmless. So far, disease-producing micro-organisms have not been discovered.

FILTER BEDS IN HOLLAND.

Some interesting details regarding filtering plants in Holland are given in an article by H. P. N. Halbertsma in a recent number of the "Journal fuer Gasbeleuchtung und Wasserversorgung." The article is accompanied by sections through portions of beds in 14 cities and by three diagrams, reproduced herewith and referred to below. The translation of the article, with slight changes, is as follows:

As a rule the Dutch filter-beds are constructed with sloping side walls, which may have been caused by the conditions of the ground and the presence of ground-water. The results, however, are most satisfactory. At an average the height of water is 3.28 ft. above the top of the filtering sand. The average depth of the filtering materials is 3.28 ft., sometimes 4.9 ft. is the zero line. To admit of a practical comparison the filter-beds of Great Britain and Germany are shown in a similar manner.

It will be seen from the sections and the diagrams that the thickness of the various filtering materials has a wide range in all of the countries. As a whole the filter beds of the Netherlands use much less of gravel and coarse materials than the other countries, while the general practice in Germany, Great Britain and Ireland is quite similar. In depth of sand the practice in all the countries is more nearly uniform, both in the comparison of countries and individual cities. The sand is really the filtering material, the coarser matter acting as a drain. Moreover, the thin upper layer of sand does the work, but as this is removed at intervals the deeper the sand



SECTIONS OF FILTER-BEDS IN 14 DUTCH CITIES; AND DIAGRAMS SHOWING COMPARATIVE DEPTHS OF WATER AND OF FILTERING MATERIALS IN PRINCIPAL FILTER BEDS OF GERMANY, THE NETHERLANDS AND GREAT BRITAIN AND IRELAND.

A thickness of 1.64 to 2.46 ft. of the sand layer and the same dimensions for the coarser materials, as gravel, sea shells and broken stones, is deemed sufficient.

It will be noticed in most of the filter-beds that pile foundations are either dispensed with altogether or used only to a limited extent. The sides show slopes of 1 to 1 or 1½ to 1 and are constructed of two or three flat courses with a layer of 1.64 ft. of puddled clay underneath to prevent leakage. The beds are not covered.

Where the water is filtered twice, the primary filter usually consists of coarse river sand; for the secondary fine dune sand is used. The results thus obtained, however, do not justify the increased expenses.

The comparative depths of filtering materials and water upon the beds are graphically shown in the accompanying diagrams; the surface of filter in all cases

the less frequent the renewals of all the sand used. The Netherlands shows much uniformity in the head of water on the beds, and Great Britain and Ireland show a wide divergence in this respect.

The filter bed at Poughkeepsie, N. Y., has 24 ins. of fine sand at the top, then 18 ins. of ¼-in. gravel, 6 ins. of 2-in. broken stone, 24 ins. of 4-to 8-in. broken stone, making a total of 6 ft. of filtering material. Some of the results obtained from this filter were given in our issue for April 28, 1892.

At Hudson, N. Y., there is a filter bed with the same total depth of material as at Poughkeepsie, 6 ft., but more finely graded from fine to coarse, as follows: 6 ins. fine white sand; 18 ins. coarse dark sand; 6 ins. ¼-in. gravel; 6 ins. ½-in. gravel; 6 ins. 1-in. broken stone; 6 ins. 2-in. broken stone; 24 ins. 4-to 8-in. broken stone.

The depth of water on these beds is not known.

WORLD'S COLUMBIAN EXPOSITION.

(With inset.)

Erection of the Manufactures Building.

The largest building of the Exposition, and one of the largest buildings in the world in regard to floor area, will be the Manufactures and Liberal Arts Building. It is situated on the lake front, and is rectangular in plan, 1,687 × 787 ft., with an area of 30.5 acres. The architect was Mr. Geo B. Post, of New York, and the cost is estimated at $1,000,000. The general design was illustrated in our issue of Feb. 13, and a view of one of the completed steel arch roof trusses of 368 ft. span was given in our issue of May 12, with particulars of the erection. The exterior portion will be of timber construction, with staff covering and decorative work, as on all the main buildings. The most interesting work from an engineering point of view is the central portion, with steel arch roof trusses, 368 ft. span and 210 ft. high, being the largest roof trusses in the world and covering the main court of this building. The trusses are of the three-hinged type, like those of the Machinery Building, illustrated in our issue of June 30, but the latter are 115 ft. span and 93 ft. 6 ins. high, and the springing line is 35 ft. 11 ins. above the base. Both of these great roofs were designed by Mr. E. C. Shankland, Engineer of Construction. There are 6,000 tons of steel work in this building. The contract for this has been let to the

Edge Moor Bridge Works, of Edge Moor, Del., and the work of erection, now in progress, is being carried on by the erection department of that company.

In considering a method for erecting these steel trusses the endeavor of the contractors, the Edge Moor Bridge Works, of Edge Moor, Del., was to devise a plan that would admit of the largest number of men being worked to advantage and at the same time to use a method by which the steel work could be conveniently and quickly handled with the minimum amount of staging; for, in the first place, the time allowed for constructing this great roof was very limited, and in consequence it was necessary that the erection should be pushed as rapidly as possible; and, in the second place, the movable staging or traveler would in any event have to be very large and heavy, on account of the height of the arched roof. The method of erection adopted and the traveler used, were designed by Mr. S. P. Mitchell, Assistant Manager of the Edge Moor Bridge Works, and are very clearly indicated by the drawings on our inset sheet.

The traveler consists essentially of three towers; one central tower 222 ft. 6 ins. high and two side towers each 134 ft. high. The central tower is 80 ft. wide at the base and the side towers are 50 ft. wide, c. to c. of outside vertical posts. These three towers are connected together, as shown, so as to carry a platform at a height of 134 ft. above the floor of the building. The traveler is carried on 28 heavy wheels, 20 ins. diameter, running on eight lines of rails, and is moved forward by the three six-spool hoisting engines of 24 HP. each, located on the lower platform. About 190,000 ft. B. M. of Oregon fir lumber and 75,000 lbs. of iron were used in its construction, and its weight is something over 700,000 lbs.

Four booms, each 62 ft. long, are attached to each end of the traveler and are operated by two 24 HP. hoisting engines, each having six independent spools or winch heads, located on the lower platform. Four booms, 36 ft. long, are attached to the upper section of the central tower, and are operated by one six-spool engine of 24 HP., located on the floor of the building. In addition to these booms, two small travelers having four booms each are arranged to move on tracks laid longitudinally on the upper platform of the main traveler, and are operated by two four-spool engines of 14 HP.

The arches in the buliding are spaced 50 ft. c. to c., so that when the traveler is standing in position the arches and the outside vertical posts of the traveler are on the same planes. In this way two arches can be erected simultaneously over the traveler, and when these are connected the traveler is moved 100 ft., or the length of two bays, the next pair of arches erected, and so on. The material is run into the building on two temporary and movable tracks laid on the floor parallel to the long side of the traveler or crosswise of the building.

The arch sections from the lower pins up to pins A, at the corners of the traveler, are set in place by the eight long booms on the ends of the traveler, and the longitudinal girders connecting the arches are also put into position by these booms. The arches at pins A rest against plungers carried on hydraulic jacks, and are further attached to the traveler by means of the adjustable loop rods shown in the detail drawing. While the lower sections of the arches are being erected the material for the upper sections is being hoisted to the upper platform by the four booms on the central tower, distributed on truck cars, and set into place on the curved falsework by the two top travelers.

When the material for one side of the two arches is assembled on top of the traveler the ribs are connected together by the purlins and sway rods and hoisted bodily into position around pin A as a center, by tackles swung from the central tower. The assembling of material for the two arches on the other side of the traveler is then completed, and they are hoisted into position from the tower. Before these hoists are made, however, the pins A are spread about 3 ft. further apart, crosswise of the building, than their proper distance, so as to allow one side of the arch in hoisting to clear the side that has been hoisted first. After both sides are hoisted on the tower they are slacked down a little until the half pin holes at C are exactly opposite. This, of course, leaves the joints at B open. The jacks supporting the arches at the corners of the traveler are then eased off, which at once throws the two sides of the arches together on the pins C and closes the joints B. As soon as these joints B are bolted up the arches are connected and are swung free of the traveler by slacking off the tackles on the central tower. By swinging around the long booms, the traveler is entirely clear of the inside line of the arch, with the exception of the top section of the central tower which stands up between the arches. This section is arranged so that it can be lowered down easily, thus clearing the traveler, and making it ready to be moved forward to the second bay ahead. The pins at A were introduced entirely for the purposes of erection, and this joint is fully spliced as a stiff joint when the arches are connected.

Each section of the arch in the 16 common arches, which is raised bodily from the central tower, weighs 32 tons, and in the two special arches 40 tons. About half the weight of each one of these sections is carried on the central tower in raising. The lantern frames, jack rafters, etc., are put into place with small travelers running on the purlins by a gang that follows the large traveler.

The first pair of arches was erected in nine days of ten hours, the second pair in eight days, and the fourth pair in five days. About half a day is required to lower the tower, move the traveler, etc., so that the work is being done at the rate of two arches in six days. The traveler is moved 100 ft. in 45 to 60 minutes. There are about 430 tons of steel in each pair of arches, including longitudinal bracing, etc. The floor of the building was laid before the erection of the trusses commenced, which made it necessary to put in independent falsework to carry the traveler tracks in order to prevent settlement in the floor from the large concentrated loads.

Transportation Exhibits.

Intending exhibitors in the Transportation Department are notified by a circular issued by Mr. Willard A. Smith, Chief of the Department of Transportation Exhibits, that all applications for space must be made before Aug. 1. Applications already received call for at least twice as much space as there is to be disposed of. All applications received up to the end of July will be entitled to consideration, and allotment of space will then begin. the value and importance of said exhibit in its relation to the whole will be duly considered. The chief end to kept in view will be the completeness and general merit of the whole exhibit of this Department, and exhibitors have been urged to plan for the best exhibit rather than the largest, and to especially study economy of space. The artistic effect of exhibits will have much to do with their location in the building. The Baltimore & Ohio R. R. Co. will expend $75,000 upon its exhibit. By order of Vice-President Lord, Major J. G. Pangborn is vested with the full direction of all matters pertaining to the company's representation, and will control its management during the exposition. Arrangements have been made for the construction of full-size reproductions in wood of the early examples of motive power and equipment upon the pioneer railways of the world. The evolution of the locomotive will be a striking feature of the exhibit, and will commence with the first conception of the use of steam for propulsion of vehicles upon land, of which history has a record—that of Sir Isaac Newton, in 1680. The development of the essentials of locomotive perfection will be followed in the original size reproductions, all of which will be so made as to permit of the workings of the representations of the machinery, affording a practical comprehension of the ideas and conceptions of those who have made possible the locomotive of to-day. The work will be upon the lines perfected by Major Pangborn, with Mr. W. G. O'Brien in charge and directing the practical details. In addition there will be much done at the shops at Mount Clare, both as regards the early locomotives and cars, and the examples of the modern equipment of the company.

A compound locomotive has been built at Bombay to the designs of Mr. E. B. Carroll, Locomotive Superintendent of the Bombay, Baroda & Central India Ry., the engine being a simple engine rebuilt. The intercepting valve is of a pattern designed by Mr. Lindsley, Chief Draftsman.

CRUDE OIL FOR FUEL AT THE MINNEAPOLIS WATER-WORKS.

The following interesting information regarding the use of crude oil for fuel at the north side station of the Minneapolis water-works, showing a sensible economy in favor of oil, was given us by Mr. Andrew Bergstrom, Chief Engineer Minneapolis Water-Works.

There are two 15,000,000-gallon Worthington high-duty pumping engines at this station, on'y one of which is generally in use, although the other is always ready for service. These pumps have 33-in. high pressure and 66-in. low pressure cylinders, 33-in. main plungers, all of 50-in. stroke.

There are six steel boilers, each with an inside diameter of 9½ ft. The shells are 15 ft. long and ½ in. thick. There are 118 3-in. tubes in each boiler and two corrugated steel fireboxes 42 ins. in diameter. Each boiler has a total heating surface of 1,557 sq. ft., a total grate surface of 37 sq. ft. The calorimeter of the tube area is 5.79. Four boilers are required to run the plant and four have been changed to burn crude oil.

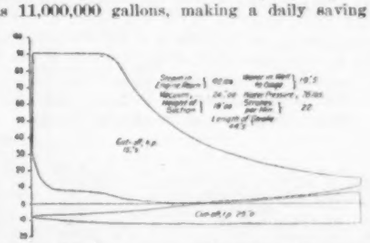
The comparative results obtained from bituminous Youghiogheny coal and crude oil as fuel are given as follows, readings having been taken each eight hours:

Equivalent water evaporated from and at a temperature of 212° F., 8.48 lbs. with coal and 12.47 lbs. with oil, feed water being at 130° F.

The weight of the oil per gallon was 6.875 lbs.

The average amount of coal used to raise 1,000,000 gallons 195 ft. was 2,400 lbs., which at $4.50 per ton cost $5.40. The average amount of oil used for the same work was 240 gallons, which at 2.14 cts. per gallon cost $5.13, or 27 cts. per 1,000,000 gallons pumped less than the coal.

The average amount of water pumped p r day was 11,000,000 gallons, making a daily saving in



Indicator Diagram from 15,000,000-Gal. Worthington High Duty Pumping Engine Using Crude Oil Fuel.

favor of the oil of $2.97. In addition, the labor saved amounted to $8.75 per day, which made a total daily saving of $11.72.

These figures, as has been stated, are with oil at 2.14 cts. per gallon. Later the price of oil was raised to 2.43 cts., and on April 2 Mr. Bergstrom informed us that the next consignment of oil would cost 2.65 cts. per gallon. For the two weeks just expired when Mr. Bergstrom wrote it had taken 23⅓ gallons of oil to lift 1,000,000 gallons of water 195 ft. At 2.65 cts. per gallon the cost of oil would be $6.17 for 1,000,000 gallons pumped, or 77 cts. more for fuel than when coal is used. For a day's pumpage of 11,000,000 gallons the oil as fuel would cost $8.47 more than the coal, but this is offset by a daily saving of labor equal to $8.75, making a gain of 28 cts. per day, 2.545 cts. per 1,000,000 gallons, or $102.20 per year in favor of oil.

Oil has been delivered at the pumping station, Mr. Bergstrom states, for less than 2 cts. per gallon. He also states that to the date of his letter the city had been unable to contract with the Standard Oil Co. for crude oil.

The averages given were calculated from the operations of the plant in regular service and include fuel used for all purposes. It is estimated that 5% of the fuel was used for running an electric lighting plant, heating the buildings, and for steam jackets on the extra pump kept ready for service. An allowance of 1% was deducted from the pumpage for slippage, but no allowance was made in head pumped against for the friction in two bends of the suction pipes.

The accompanying illustration shows a steam card taken from the 15,000,000-gallon high duty Worthington pumping engine at the above named

station on April 2. The height of suction on that date was 18 ft.; length of stroke, 49.5 ins.; high pressure cut-off, 15.5 ins., and low pressure, 25 ins.; steam in engine room, 92 lbs.; vacuum, 26 ins.; water pressure, 76 lbs.; strokes per minute, 22.

RAILWAY STATISTICS IN ILLINOIS.

The report of the Illinois State Railroad Commission is one of the very few from our Western states in which the discussion of traffic and legislative questions does not predominate to the exclusion of the more technical questions affecting safety and economy in the maintenance and operation of the several railways. In the report for 1891, recently issued, the amount of valuable matter is unusually large, and, except in a few minor details, is quite well arranged for use. Some of the more interesting of this matter is given in the accompanying tables, which we have compiled and calculated from the figures given in the report.

First, it is interesting to note that with 10,180 miles of railway, the largest mileage of any state in the Union, the aggregate mileage of second, third and fourth track is only 1,056 miles, and that over 67% of this is on four roads and mostly in the vicinity of Chicago. This report was made, however, before any active work had been done toward increasing the capacity of the railways in anticipation of the increased traffic to the World's Columbian Exhibition, and another year is likely to show considerable advances over these figures. This line is capitalized to an amount of $54,383 per mile, made up as follows:

	Per mile of railway.	Per cent. of total.
Capital stock	$24,575	45.06
Bonded debt	27,831	51.46
Current liabilities	1,977	3.48
Total	$54,383	100.00

The average capitalization of all railways in the United States as given in the last report of the Interstate Commerce Commission is $60,340 per mile.

The physical character of the track is shown in

Table 1.—Showing Mileage of Railway, Rails, Ties, Ballast, Bridges and Trestles in Illinois.

	Miles.	P. c. of total m'age.
Mileage of railway, main line	10,180	100
" laid with steel rails	9,234	90.7
" " " iron "	946	9.3
" of stone ballast	991	9.75
" " gravel "	4,218	41.5
" " cinders "	586	5.76
" " slag "	157	1.55
" " earth "	4,030	39.6
" " sand "	193	1.94
" " bridges "	47	0.46
" " trestles "	156.4	1.53

Table 1. The large percentage of earth and sand ballast, 41.5% of the total, is especially noticeable and is somewhat surprising considering the financial standing and heavy traffic of most of the lines. An equal amount is gravel, and nearly 10% is rock. As on most of our prairie roads the doubtful economy of compensating for poor ballast by using somewhat heavier rails and a large number of cross ties is practiced. The ratio of the mileage of bridges to trestles is much larger than in most Western states. About 49% of the bridges, however, are either wood or combination, wood and iron.

The number of crossings of highways and railways in the state is given as 11,485, made up as follows:

Overhead railway crossings	75
Overhead highway crossings	321
Grade highway crossings	11,089
Total	11,485

In this connection it is of interest to learn that the Commission, through its engineer, is preparing an elaborate report upon interlocking apparatus as used in foreign countries, especially Great Britain, in its work of securing state legislation on this subject. We hope to discuss this report at length in a future issue.

Favorable progress is shown in the use of train brakes and automatic couplers, as will be seen from Table 2. Of the 31,034 cars equipped with automatic couplers given by the report as in use on equipment owned by the several companies (which are very absurdly given in total only for both passenger and freight), 18,107 are of the Janney type. Of the remainder 3,613, 3,431, 2,380 and 1,075, respectively, are of the Janney-Gould, Miller, Gould and Chicago types, and 601 and 588, respectively, are of the Hinson and Janney-Miller types. In general only well established types of couplers are being used. The total number of passenger cars in the state, all of which are equipped with automatic couplers, will be seen in Table 2 to be 5,303.

Table 3.—Showing by Classes the Tonnage of Freight Moved in Illinois and Pennsylvania.

	Illinois. No. tons moved.	Illinois. P. c. of total ton'ge.	Pennsylvania. No. tons moved.	Pennsylvania. P. c. of total ton'ge.
Products of Agri.	9,943,724	17.3	14,898,303	6.28
" " animals.	5,090,568	8.6	6,369,761	2.64
" " mines.	18,598,520	32.6	152,915,899	64.11
" " forests.	3,900,223	6.9	14,706,573	6.17
Manufactures	6,394,117	11.2	35,467,139	14.82
Merchandise	3,209,629	5.3	6,865,705	2.84
Miscellaneous	10,346,568	18.1	7,561,835	3.14
Total	56,573,349	100	238,765,215	100

The diversified character of the state's industries is very clearly shown in Table 3, giving the tonnage of freight of different classes moved. For the purpose of comparison we have included similar figures for the state of Pennsylvania. A portion of the railway mileage included for Pennsylvania lies outside of the state, but the character of the traffic and conditions of operations are so nearly the same that the general percentages are not appreciably affected. The very large proportion of the total traffic which is furnished by the products of mines and manufactures is noticeable, especially in Illinois, which is generally considered as primarily an agricultural state. Even in Iowa agricultural products furnish only 21.7% of the total freight tonnage, and in Minnesota 36.7%.

Table 4.—Showing Tons of Freight Carried One Mile per Ton of Fuel Consumed by Freight Engines; Fuel Consumed per Freight Train Mile, and Cost of Coal per Freight Train Mile.

Railway.	Tons of frt. carried one mile per ton of fuel consumed.	Fuel consumed per train mile, lbs.	Cts., cost of coal per mile run
Chic., Santa Fe & Cal.	3,070	119.	10.
Baltimore & Ohio	4,383	128.	10.7
Chic. & Alton	3,260	95.8	8.75
Chic. & E'n Ill.	6,630	110.3	5.2
Chic. & Grand Trunk	4,050	91.0	9.1
Chic. & Northwestern	1,610	100.0	8.65
Chic. & Ohio R.	1,140	44.0	2.7
Chic., Mil. & St. P.	3,770	74.8	7.2
Chic., R. I. & Pac.	3,720	68.6	6.07
Chic., St. L. & Pitts.	4,610	100.5	8.95
Chic., St. P. & Kan. C'y	2,830	115.7	9.73
Cleve., Cin., Chic. & St. L.	4,160	101.6	5.23
Kankakee & Seneca	6,260	79.7	6.43
Peoria & E'n	2,910	123.5	7.87
Elgin, Joliet & E'n	2,390	140.9	10.08
Fulton Co. N. G.	1,120	59.0	3.29
G'nd Tower & Cape Gfrar.	2,830	82.8	3.87
G'nd Tower & Carbondale	2,740	106.9	5.35
Illinois Central	2,400	144.1	7.13
Ind. & Ill. S'n	1,001	112.7	5.05
Indianapolis, Dec. & W'n	2,590	73.2	4.98
Ind., Ill. & Iowa	5,180	89.9	6.22
Iowa Central	2,900	75.6	4.19
Lake Erie & W'n	4,220	85.5	6.96
Lake Shore & Mich. So'n	4,770	80.9	5.57
Louisville & Nashville	2,750	105.50	9.85
Louisv'e, Evansv'e & St. L.	2,150	100.82	9.33
Mich. Central	3,090	90.00	10.35
Mobile & Ohio	2,990	89.83	5.38
N. Y., Chic. & St. L.	2,150	106.00	9.05
Wisconsin Central	4,160	96.33	11.4
Ohio & Miss.	1,760	104.20	4.78
Pawnee	213	67.57	4.99
Peoria, Dec. & Evansv'e	3,300	88.53	3.33
Pitts., Cin., Chic. & St. L.	3,692	113.50	6.17
South. Chic. & So'n	1,513	130.30	9.07
Rock Island & Peoria	3,160	105.18	8.07
St. Louis & Chic.	2,040	88.00	3.96
St. L., Alton & Springfield	4,012	78.08	3.91
St. L., Alton & T. Haute	3,012	97.50	3.66
St. Louis & Peoria	1,582	138.00	4.16
T. Haute & Indianapolis	3,195	95.46	5.12
Toledo, Peoria & W'n	1,532	84.69	4.63
Toledo, St. L. & Kan. Cy.	5,470	81.99	3.53
Wabash	3,470	96.35	5.71
Wabash, Chester & W'n	1,754	60.37	2.29
Total, all lines	3,229	103.61	.....

The cost of coal per train mile is generally from 5 cts. to 10 cts., except in a few cases where, owing to the low price of coal, it falls to 4 cts. per train mile. In the cases where the cost falls below this the low figures are probably due largely to exaggerated train mileages, as they are generally accompanied by a small fuel consumption in pounds per train mile.

One of the most interesting tables given in the report is that showing the amount of fuel consumed by locomotives doing various classes of work, the miles run by such locomotives, and the average number of pounds consumed per mile run, though figures purporting to give the average fuel consumed by switching locomotives per mile run are of very little value. These reports show variations in switching engines from 24.06 lbs. per mile to 110.3 lbs. per mile, which are undoubtedly due almost entirely to an assumed mileage greater or less than the actual mileage, as the case may happen to be. From the figures for freight locomotives we have calculated Table 4. In making up this table the total tons of fuel consumed, both coal and wood, as given in the report, were used, 1½ cords of hard wood and two cords of soft wood being considered equivalent to one ton of coal. Only a very small percentage of the total was wood. The first column of figures shows the relative amount of service obtained by the several roads from the consumption of one ton of fuel. The variations in the quality of coal used by the different roads, which are small, being disregarded, it also indicates the relative extent to which the earning capacity of the locomotives have been utilized, or, in other words, the ratio between the net and gross loads hauled. The number of tons of freight carried one mile per ton of coal consumed varies from 213 tons on the Pawnee R. R., having a light local traffic, to 6,630 tons on the Chicago & Eastern Illinois R. R., which has a heavy coal and through traffic.

Table 2.—Showing Progress in the Use of Automatic Train Brakes and Couplers in Illinois.

	No. 1890.	No. 1891.	Per cent. increase.	P. C. fitted with train brakes. 1890.	P. C. fitted with train brakes. 1891.	P. C. fitted with automatic couplers. 1890.	P. C. fitted with automatic couplers. 1891.
Locomotives	6,956	7,327	5.33	63	67.13	.....	4.61
Passenger cars	4,771	5,303	11.15	97.7	99	94.2	98.08
Freight cars	207,142	215,115	3.84	5.54	8.35	7.99	10.97
Cars in Co.'s service	5,792	6,672	15.19	0.80	1.15	0.15	2.81
Cars in fast freight service	17,510	16,751	4.33	1.43	1.7	6.29	10.22
Total	235,215	243,841	12.58	6.90	9.66	9.41	12.58
Cars and locomotives leased	19,125	21,973	14.88	.....	9.14	.....	10.07

NOTES ON FOUNDATION EXPERIENCES.*

The plant of the Bay State Gas Co., built in 1885, is located near the pumping station of the Main Drainage Works of the city of Boston, on Dorchester Bay, and on original marsh land flooded at high tides from the bay. It was designed by the late Joseph Flannery, a leading gas engineer of Philadelphia. There are two tanks built of brick, about 30 ft. apart, each having an inside clear diameter of 152 ft., with foundation footings sunk about 30 ft. below the level of the marsh. By the terms of the contract, the contractors were to do their own engineering and inspection under the plans furnished, the principal requirement given being that the tanks should be guaranteed water tight and true to circle. Material used was hard burnt Eastern brick, laid in improved Union cement, and coarse gravel concrete made with Portland cement.

The physical conditions under which the tanks were to be constructed were rather forbidding, particularly in view of the difficulties met in securing the foundations for the pumping station of the drainage works some 500 ft. from the site of the tanks. No borings had been taken, it being assumed that the material to be gone through was substantially of the same character as that met with at the pumping station, starting with the marsh mud, stiffening up as clay, and reaching the sand which was strongly water bearing as would be expected. The enormous area occupied by each tank dictated large pumping capacity.

The mode of construction adopted was as follows: The site of the tanks and construction plant, covering some two acres, was first diked off from the sea, which flooded the marsh at high tide. Immediately between the tanks a sump well 10 ft. square was sunk and planked up, into which all drainage was to be carried. The pumping plant consisted of two 80-HP. locomotive boilers and four Andrews centrifugal pumps, two 6-in. and two 8-in. discharge, forming a duplicate plant, it being expected that one of each size pump would be amply sufficient to care for the water under the plan of construction adopted, the other set being a relay in case of accident.

In sinking the sump, much difficulty was experienced

* Abstract of a paper by A. P. Boller, presented at the annual convention of the A. M. Soc. C. E., June, 1891.

about two-thirds the way down, from the marsh gas. The walls of the tanks were built in excavations precisely as if a circular sewer was intended, the interior core being left for excavation after the completion of the walls. The wall excavation was sloped about 1 to 1 for 10 ft., when sheet piling was introduced, 4 ins. (tongued and grooved) for the outside row and 2 ins. for the inner row. The sheeting in single lengths was mauled down as far as possible, when a small steam pile-driver was mounted and the sheeting driven clear down below the concrete footing. The driver was a small machine consisting of a single square timber mast on the apex of a triangular base, the hammer of about 500 lbs., grooved to slide over a T-rail guide secured to the mast. It was a very effective machine and easily handled.

This manner of putting in the tank walls required only a narrow excavation easily braced, reducing the demands on the pumps to a minimum. The excavations were carried on either way from the sump drains, and in sections of greater or less length as contention with water demanded. In building the brick work, to secure tightness, the bond was broken as irregularly as possible in the hearting of the wall (water abhors an angle), and to secure a thorough filling of the joints with mortar, the bricklayers were instructed to keep their fingers over the bricks and lay them a finger width apart. Each course of brick work was thoroughly grouted as the work progressed. The result was an exceedingly tight wall, as will be seen by the record hereafter given. As the wall was built up, the outside void formed by excavation was refilled with the excavated material and well rammed. The circular alinement was maintained, and vertically insured by frequent checks with a standardized steel ribbon revolved around a carefully maintained center hub and plumbing done from the end of the radius. This resulted in such accurate work, that little or no furring was required for setting the gasholder guides, and cutting into the brick was required of a trifling amount in only a few cases.

On the completion of the walls, the central core was rapidly excavated by means of three or four derricks handling yard buckets of material. Little or no difficulty was experienced in putting in the concrete bottom, excepting for about one-third the length near the footings of one of the tanks, which was conquered section by section with sheeting, and boxing in a continuous drain below the concrete. Contrary to expectations, the water difficulty was not great, and barring a short section above noted in the first tank, where sand was struck, all the water met required only intermittent pumping. Almost the entire excavation, after passing the marsh mud, was in clay, and in the westerly tank no sand whatever was encountered, consequently little or no water was met on the completion of the work. The tanks were filled to their capacity, and the engineer, Mr. Flannery, reported as follows to his company:

> The record of the two gas tanks kept from the 9th instant indicates that in No. 1 no appreciable loss has obtained; that in No. 2 a loss of 4⅛ ins. has obtained in each twenty-four hours, being from June 30 1:30 p. m., to 1:30 p. m. of the 11th instant, 5 ins., 11th to 12th; 4¼ ins., 12th to 13th inst.; 4 ins., which shows a constant betterment. That these tanks made so excellent a showing at this period of their history is unprecedented. No. 2 shows a rate of improvement which indicates an entire stoppage in the unaccounted for water in a few days. The evaporation at this season amounts to 3-10 in. in 24 hours.

The center pier of the Arthur Kill bridge, uniting the Jersey shore with Staten Island at Elizabethport, is founded upon the red sandstone of the district, and was built within a coffer dam of somewhat novel construction, with a view of avoiding all interior bracing, which interferes greatly with the rapid and economical building of masonry. The tides run very rapidly in the Kills, and the traffic is of enormous proportions, consisting largely of tows, which, in a comparatively narrow channel, were often forced by wind and tide in close proximity to the center pier. Any coffer dam had, therefore, to be built within the narrowest limits. The physical conditions at the site of this pier were nearly level rock bottom (the sandstone being in its natural bed, with over 10 ins. pitch to the eastward in the width of the dam), overlaid with about 2 ft. of clay under some 18 ins. of sand and mud, and a depth of water over the rock of 28 ft. at high tide. The plan of dam adopted was a double-walled polygon of twelve sides, the walls being 4 ft. apart in the clear, within which the puddle was placed. The inscribed circle of the inner wall, measuring the free working space, was 42 ft. 6 ins. in diameter. The walls of the dam were built up of square hemlock timbers halved into each other at their intersections, and proportioned under the consideration of a horizontal polygonal arch, subjected to a uniform load of water due to the head at any point. The separate walls were tied together by bolts and round struts of barked pieces of piles at intervals, the round struts being adopted to allow the puddle to freely run around them as shoveled in. The bolts passed through clamp timbers of yellow pine 6 × 12 ins., the whole depth of the dam. For convenience of building, these clamps were scarfed in two lengths. The interior struts butted against pieces of 6-in. plank, so as to catch all the wall timbers.

The dam was built on the shore in launching ways for about one-third its height, when it was launched, and towed to its location, and was built up until grounded in position. Between each course of timber and at the scarfing of the joints, a line of cotton wicking was introduced, which by swelling would aid tightness of the walls, and prevent the puddle seeking under a strong head of water a vent through unevenness of the timber, which events proved to be a wise precaution. The courses of timber were drift bolted every 3 ft. with ⅞ × 18-in. bolts, and the scarfed corners were additionally fastened with 10 x ⅝-in. spikes.

Previous to launching the dam, the site of the pier had been prepared by dredging the rock bare, and settling in place the crib blocks on either side, constituting part of the permanent fenders, which are all crib work. The dam, 56 ft. across, projected into the channel beyond the fenders 3½ ft. on either side.

The dam was settled in position and held in place by piling on some of the stone which was to be built in the pier, when the puddle was filled in between the walls. This puddle was a very hard gravelly clay, from a bank near by, exceedingly difficult to dig, but which packed splendidly under the water as it was thrown in, and made an ideal material for the purpose. Before pumping out, the bottom was prepared by depositing under water a rich Portland cement concrete, containing 3 bbls. of cement and 9 bbls. of sand to 1 yd. of stone. It was deposited from triangular buckets of 1 yd. capacity and placed by divers, until there was 4 ft. of concrete all over the dam. After allowing the concrete to harden for about a week, the dam was pumped out in a few hours for the masons to start their work, and proved tight with one exception, and that was a very small area about 5 ft. from one of the walls, where the divers had omitted to properly cover the bottom with concrete, and quite a lively spring spouted up from the bottom. We always believed this to be from a fissure in the rock, and not from under the dam, as the outside edge of the dam had been carefully gone over, foot by foot, by the diver, who bagged with clay any suspicious place, besides which the splendid character of the puddle, so well boxed in, seemed to insure a perfect luting with the rock. As the spring refused to be stopped, it was boxed in and led to the sump, the concrete leveled off and the masonry started, and the box built into the pier.

There was some groaning of the timbers as they settled to their bearings, and quite a perceptible bend to the lower timbers of the inside wall. The tie bolts drew nearly half way into the clamp timbers, a couple of which split up at the scarf joint. The seams between the wall timbers were remarkably tight, thanks to the cotton wicking, although in a few places when the irregular scantling made too wide a joint the cotton leached out, followed by some clay, but such leaks were quickly stopped by pieces of plank spiked over the seams and calked. The 6-in. centrifugal pump took care of the drainage with perfect ease, and was only run intermittently. Had it not been for the bottom spring before described, a 3-in. pump would have been amply sufficient to take care of all seepage or wall leakings. The only improvement that could have been made in this dam, would have been to have used 10-in. instead of 6-in. clamp timbers, and larger bolt washers; and a direct miter joint of the wall timbers instead of scarfing would have made better bearings, but in that case it would have been difficult to have made a unit of the dam for launching, handling and placing, and would have required iron clamps or some device for holding the courses together.

This dam required 140 M. B. M. of timber, 15,000 lbs. of iron, and 600 cu. yds. of puddle, and is believed to be, for the area embraced and depth of water, as economical and safe a dam as was ever built, to say nothing of the immense gain in freedom from intermediate cross bracing.

Pier No. 4 of the same bridge, near the Staten Island side, was almost in the sweep of the tows, and putting in the foundations was looked forward to with no little anxiety. It was necessary to have the stoutest kind of fender guards (which were to be permanent), and a system of oak piling and bracing was devised and put in place. At this point to hardpan bottom from high water was 34 ft.; the bottom being overlaid with some 3 ft. of clay and 6 ft. of sand, with an irregular mud line on top, sloping shoreward from 9 to 10 ft.

It was the original intention to dredge to hard bottom and put in a double walled squared timber coffer dam, similar in construction to that used for the center pier previously described, but of rectangular shape, and cross bracing as the water was lowered; but as it would have projected beyond the fenders into the channel, and would almost certainly have been run into, it was deemed more prudent to sink a caisson with a coffer dam top, which could be kept within the protection of the fenders. On account of the teredo, the caisson was planned so as to cut out the roof after the chamber had been filled with concrete, and the masonry started on the exposed concrete footing. To this end the caisson was built with a roof having a single layer of 12-in. timbers, with ceiling plank on the under side, the roof being broken into the spans with rods. The air chamber had a clearance of 7 ft. The bottom was prepared by dredging, when the caisson was floated into place and the coffer dam sides were planked up and calked as the caisson sank with the weight added from time to time, which, in addition to the water, consisted of the necessary quantity of ashlar stone, which would afterward be built into the pier. After the caisson was landed on the bottom, sufficient stone was added to balance the air pressure and the concreting proceeded with in the usual way. When the chamber was filled, the coffer dam was pumped out and stone removed, but the reduction of weight was too much for the concrete, which evidently had not bonded with the bottom, or possibly a leakage between the roof and concrete, or both combined and the whole dam lifted up about 3 ins. at one end. As it was hopeless to endeavor to force it back to place, and there was no telling how much the concrete was demoralized, there was no help but take it out and begin all over again, which was done after a good deal of trouble. More care was exercised in removing the weight, and it was finally concluded to build immediately on top of the roof timbers and not undertake to cut them out. This simplified the work and the masonry was started in sections, until enough courses were built to insure all the dead weight needed against the extreme head, when the rest of the pier was run up in the usual way. As the timber deck was below river bottom, a little rip-rap insured it against any possible exposure to the teredo. The pneumatic work and coffer dam was performed under a sub-contract with Sooysmith & Co.

Pier No. 5, of the same bridge, is near the edge of the marsh forming the Staten Island shore, which is barely flooded at extreme high tides. Borings indicated about 30 ft. from surface of the marsh to hard bottom, consisting of mud, mud and clay mixed, through more or less sand into clay, clay and shale to the bottom of shaly clay, on which the pier was to be founded. Experience on the Boston tanks, previously referred to, seemed to indicate that the founding of this pier would be accomplished with little difficulty. The area of the foundations was inclosed with a tongued and grooved sheet pile dam of 4-in. yellow pine plank; but it was found impossible to hold the plank at a depth of 15 ft.; the mud and clay became puddled with water, and despite all efforts at bracing, the plank shoved inward to such an extent as to spoil the whole dam before we were half way down. A second dam was therefore driven around the first one, but this time with 10 × 12-in. tongued and grooved timbers, in one length, to reach the extreme bottom. These timbers were grooved by slitting the grooves out at the mill with a circular saw and chiseling the blank so formed, free. The tongue was an independent "spline," 2½ × 4 ins., of dry wood, and nailed in one groove. The timbers were shaped at the feet to drive close. This dam was hard driving, but was finally accomplished, when digging was resumed, and the old dam removed piecemeal as we could get in the braces. The bottom was reached within a perfect dam, with only one bad leak in the northwest corner due to the shattering of a small piece of one tongue during the driving. As it was impossible to stop this leak from the inside, and the outside was inaccessible, to prevent washing the concrete the leak was led off in a box at the side of the dam to the sump well, and the footing course of concrete, filling the whole area of the dam about 7 ft. deep, was put in place.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 54.)

Worcester, Mass.

The chemical precipitation plant for the purification of the sewage of Worcester, Mass., was described and illustrated in Engineering News of Nov. 15, 1890. Since that description was written some changes and experiments of interest have been made, and at present the daily capacity of the plant is being increased to 15,000,000 gallons by adding 10 new tanks, which will make 16 altogether. When first put in operation, June 25, 1890, and for some time, only 3,000,000 gallons daily were treated. Later the amount treated was increased, and on June 19, 1891, the daily treatment of 6,000,000 gallons was begun. This amount was in excess of the capacity of the plant, but it was considered better to treat this amount partially than a smaller amount thoroughly, as all the untreated sewage goes into the Blackstone River. When the writer visited the plant on June 17, 1892, about 4,000,000 gallons was being treated daily.

In 1886 the Massachusetts Legislature passed an act requiring Worcester to purify its sewage before discharging it into the Blackstone River. This river had become fouled with sewage, and its daily flow was so polluted that the manufacturers and residents along its course below the city united and secured the passage of the above law.

Mr. Chas. Allen, City Engineer, visited European sewage purification works, and finally recommended the construction of the chemical precipitation plant put in operation June 25, 1890.

The combined system is almost exclusively used in Worcester, a few lines having been built recently on the separate plan where there was a good opportunity to dispose of the storm water aside from the sewers.

The sewerage of the city formerly found its way to the Blackstone River through Mill Brook, which is being gradually inclosed with masonry. This dilutes, but at the same time increases the volume of the sewage to be treated. Measurements have shown as high a daily flow of the brook as 19,500,000 gallons and as low a flow as 6,000,000 gallons, the latter in August and September and on holidays when the mills were not running. Measurements are made from time to time by turning the full flow of the brook into the settling tanks connected with the purification plant. On June 17, 1892, about 14,000,000 gallons were passing through the brook.

Mr. Allen has recommended the separation of the waters of the brook and the sewage, but this will now be postponed until after the new tanks are completed.

From Mill Brook sewage is brought to the purification works through a 42-in. circular brick sewer with a fall of 6 ins. to 1,000 ft. and a daily capacity of 15,000,000 gallons.

The precipitating chemicals are admitted to the sewage after it has passed through screens, on its way to the settling tanks and thoroughly mixed with the sewage by means of arms which project into the channel. The sewage passes slowly from one to another of the six tanks, and after being clarified by precipitation passes from the sixth tank into the Blackstone River. The sludge drains into a tank, when the settling tanks are cleaned, is raised by a centrifugal pump and passes to sludge beds.

Before considering the disposal of the sludge attention may be given to the process of purification. This, as practiced at first, was very fully described in our issue of Nov. 15, 1892.

When the works were first put in operation large and constant quantities of lime and sulphate of ammonia were used. It was soon found that the character of the sewage was extremely variable, and tests established the fact that at times, with proper manipulation, no chemicals are necessary. This change in the character of the sewage is due to the admission to the sewers at intervals of four to five hours of acids carried in manufacturing wastes. At present when the arrival of the acid sewage is detected it is at once treated with lime until thoroughly alkaline. The acid sewage flows about 1½ hours, and tanks Nos. 1 and 2 become charged with it. When this acid flow stops the adding of lime to the sewage is also stopped. The crude sewage passes into tanks Nos. 1 and 2, where the excess of chemicals is generally sufficient to serve as a precipitant for added sewage until the next discharge of acid sewage appears. In this way the amount of lime has been reduced to about one-half of that originally used. The sulphate of alumina is but little used now, there being ferric sulphate in the sewage, which, together with the above described treatment, is sufficient to clarify.

Originally the lime was ground at the works, but now it is slaked in a vat, a ton at a time. In this way about 23% of lime and 30 HP. is saved, which is partially offset by the fact that the lime must be slaked by hand. Either sewage or water may be used for slaking.

The agitators formerly used to mix the chemicals are still used, but this is because there is no other means of getting the lime through the pipes to the sewage below.

Lime made at North Adams, Mass., is now bought by the carload from L. J. Follett & Co.

During the year ending Nov. 30, 1891, there were treated 1,399,000,000 gallons of sewage, or about 3,830,000 gallons daily, from which 22,042,000 gallons of sludge was precipitated, the sludge having been pumped to sludge pits. The solids in the sludge aggregated 1,230 tons, or about 3⅓ tons a day, all of which was diverted from the river.

The amount of lime used during the year was 757.78 tons, and of alumina 64.645 tons. As has been stated, these chemicals were used in varying quantities, and often the alumina was not used at all, still giving the averages for what they are worth, and we find that for the whole year the average amount of lime used per gallon was 7.6 grains and of alumina 0.65 grains.

The disposal of the sludge, the solid part of which amounted in 1891 to 3⅓ tons per day, has been a serious problem from the start. At first the sludge was put in heaps and covered up, but this did not give satisfaction. Three different sludge furnaces were tried, but the labor involved was too great, although the sludge formed its own fuel, after once kindled. In one of these furnaces sludge containing 50% water burned quite rapidly, while some containing 72% of water burned at the rate of 2.225 tons in nine hours, unaided by other fuel. This spring the sludge which had accumulated since September, 1891, was carted away at the expense of the city and put onto farm land.

As late as the spring of 1891 there were only eleven sludge beds, covering an area of about three acres. These had been overworked until they were almost useless. When the sludge on the beds did not exceed a few inches in depth it was found that it dried quite rapidly. An area of 5.7 acres was therefore added to the sludge beds. The first beds were not underdrained, but the later ones have been. The sludge passes to the beds through wooden troughs.

The new tanks will have the same capacity each as the old ones, but will be of a different shape, their dimensions being 40 × 166⅔ ft., 5 ft. deep from the top of the weir. Sewage will discharge about 18 ins. deep over the weir. The old tanks were 66⅔ × 100 ft., 5 ft. deep. As has been stated, there will be ten of these tanks, increasing the capacity of the plant to 15,000,000 gallons per day.

In considering results at Worcester it must be remembered that the plant has generally been operated far beyond its capacity, and that no attempt has been made to treat the whole sewage of the city. Consequently those who opposed the scheme from the start and the people on the river below have expressed dissatisfaction with the results obtained. So far as can be learned the plant has given a very good effluent when not overworked, and most of the adverse criticism has been made by those ignorant of what was being attempted. It should be borne in mind that the city of Worcester is not trying to manufacture drinking water, but to prevent the most objectionable part of the sewage from going into the river. This it will undoubtedly accomplish as soon as its plant is large enough. The fact that storm water and the waters of a brook have to be handled as well as sewage is also to the disadvantage of the plant.

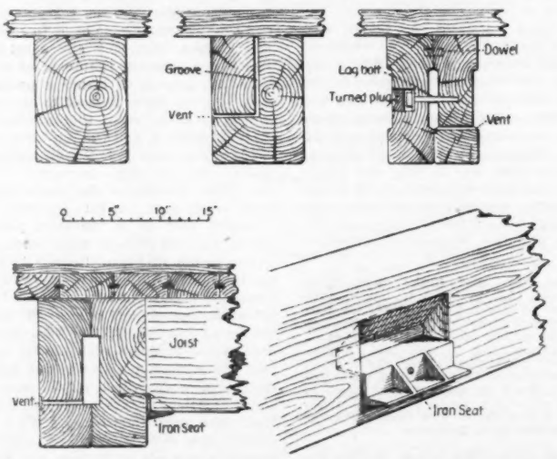
As has been stated, the City Engineer, Mr. Chas. Allen, was the engineer of the plant. Mr. F. A. McClure is now Superintendent of Sewers and Mr. H. P. Eddy is Chemist.

NEW METHODS IN HEAVY TIMBERING.

The question of the arrangement and design of timber work in buildings is one of importance, and we have received the following article on this subject from Mr. Frederic G. Corser, architect, Minneapolis, Minn.:

The great success of the system of building now much in vogue for warehouses and factories, known as the "mill construction," and the probable extension of some features of this system to other classes of buildings than those mentioned, has been productive of more or less study of the subject of timbering. If we except the efforts made within a comparatively short time to reform the timbering customary in these factories and storehouses, we must look in vain for recent examples of even tolerable timber-work. All the traditions to be acquired by the present generation of builders lie in the direction of rough, cheap work, intended to be concealed from view. No builder of this day thinks that the timbering of the ordinary building is a thing to be proud of under any circumstances. The carpenters of the day will look over the old works on the subject with rather more pity for the simplicity of the old builder, which led him to waste his time on the splendid framing shown, than of admiration for that framing.

Another factor in the decline of timber-work is the cheapness of sawing and dressing lumber in our time, which has increased the tendency to hide the actual construction by boxing or casing it in. When to this we add that the properties of timber used transversely are not generally well understood, we find sufficient causes for a decidedly low state of the art of timbering. However, with an amount of ingenuity and technical skill unknown to former times, seeking employment in every field, it were indeed a pity if the art of timbering were overlooked; and now that there are such good economical reasons for the use of heavy timbering, left in full view, we may look to see the objectionable features overcome.



NEW METHODS IN HEAVY TIMBERING; F. G. CORSER, ARCHITECT.

The accompanying cuts give some things which, so far as I know, have not been used outside of my own work, and which are submitted as in the right direction. The drying of large timbers being a slow process, proceeding from the outer and newer tree growth which shrinks most, to the inner and older wood which is more stable, we get under the ordinary conditions several unsightly cracks, due to the strains set up by this unequal drying. Aside from their unsightliness, these cracks are often of considerable damage to the timber from the standpoint of strength. The boring of posts from end to end has long been done, and when the holes thus made are of considerable size, and vented by transverse holes at top and bottom, the trouble is overcome to some extent. Were it practicable to bore the floor timbers in this way, the benefits would be even greater than to the posts, because in the timbers used transversely we could bore out a relatively large part of the center without weakening them. However, boring requires special machinery, not to be found around saw-mills or planing-mills, and there are limitations to the length of the tim-

bers that one can get bored. After trying for some years to get manufacturers of lumber to put in the necessary machinery for boring, I gave it up.

A deep groove may be worked in from the upper edge, a circular saw being specially set for the purpose. This method is open to the objection of destroying a few of the fibers opposed to the compressive strains, but it is even more efficient in reducing the tendency to crack than is the boring. The preservation from season-cracks would doubtless in some cases prevent a loss of strength that would offset the amount taken away by the grooves.

An old way of reducing the tendency to season-cracking consists in splitting the timber through the center with the saw, turning the outer sides inward, and bolting. This was a favorite prescription by Viollet le Duc. It puts the older and more permanent part of the tree-growth outward, and as this is less liable to shrink than the sappy newer growth, it not only relieves these seasoning strains by so much as would naturally follow from dividing the timber, but it also exposes the part of the timber which cracks least.

There are also other advantages in thus making up the timber in two parts, among which is the opportunity given to inspect the heart of the tree; this portion being, as is well known, subject to decay which does not manifest itself at the surface. Another advantage of using the timber of two parts is the fact that in the operations of the modern sawmill, larger timbers can in this way be sawn from a given diameter of logs. Still another gain to the building is to be found in the greater progress of the seasoning process in the interval between the cutting of the lumber and its final assembling in place in the building.

Not long since it occurred to me that possibly broad grooves or panels might be worked in the sides of the pieces thus proposed to be bolted together, the operation being done at the planing-mill at the time of dressing of lumber. Upon inquiry, I find that the planers in use at these mills for doing the bulk of their work may be easily modified to work these channels, and I have had estimates for doing it at a very low figure.

As grooves or panels of about the proportion shown in the cuts may be made without taking from the strength of the pieces when subjected to transverse strain, this form becomes desirable for several reasons. The seasoning of a timber prepared in this way would be accomplished in a fraction of the time required by a solid timber; the paneling would so reduce the pieces at the center as to remove the tendency to season-cracks; considerable weight would be saved in freighting and handling on the building; the interior could be dried while the under side of the timber, being practically solid, would resist fire well, and if the outer sides were also paneled, it would do much toward relieving the appearance of the timbers, by introducing lines that would in a measure take the attention from the unsightly features of common lumber. In fact, this treatment of timbers will go far toward making open timber-work desirable in other classes of buildings than factories and warehouses. Floors built on this principle are much to be desired in schools, for instance, where by their substitution for the common thin joist and concealed construction, and by the use of open-timber roofs of suitable detail, a practically fire-proof building may be obtained at less cost than one of the kindling-wood structures so nearly universal.

I am indebted to Mr. C. J. H. Woodbury for the suggestion that the small vent-holes be placed at a low enough level to drain the inside of any water that might get into the center during or after building. For bolting the halves of the timber together, lag-screws are used as shown, because they would not become so loosened by the shrinkage of the wood as would the common bolts running clear through. A few dowels might be inserted with profit in the upper part of the girder liable to unequal loading, as the planking, being parallel with it, would not be of assistance in distributing the load over the two halves. These dowels, replacing fibers subject to compressive strains only, would not take from the strength of the beam.

The iron stirrup, so commonly used for the support of timbers meeting at right angles, as when heavy joists are carried at one or both ends by girders, is far from an ideal way of accomplishing the desired result. It is clumsy in appearance, if not actually so in manufacture; it usually gives a rather poor bearing for the joist, while the shrinkage of the joist eventually leaves the top of it considerably below the top of the girder. The iron seat shown in the cut is designed to overcome these faults in a degree.

As we approach the neutral axis of the timber in which the mortise is cut, we find the fibers less and less strained under a load, so that we may remove a part of the timber without weakening it, provided we leave enough wood at this point to bear the small strains that the timber will be called on to withstand at the level of the mortise. If in this mortise we place a casting of the form shown, and tenon the joist to fit, we shall get a bearing for the joist much better than that given by the stirrup; the arrangement will be much less unsightly, and nearly all the old trouble of shrinking away from the common level at the top, which gives so much trouble where stirrups are used, will be overcome.

FOUR-DRUM HOISTING ENGINE.

A form of hoisting engine has been brought out recently by Thomas Carlin's Sons, of Allegheny, Pa., which is very similar to the engine by the same firm illustrated in our issue of Jan. 2, and is specially designed for operating a derrick to handle coal, sand, etc. Several of these engines are being built. They are said to be strongly geared, and all shafts are of large diameter, with ample bearings. The four drums are operated by a patent friction appliance at the ends of drum shafts. In addition to the four drums there is a cat-head or winch on one of the drum shafts which is used for moving and swinging barges. The two front drums are 16 ins. diameter and are used for raising the load, and also for raising and lowering the boom, thus changing the radius at which the load may be hoisted and delivered. The two back drums are of similar diameter, and are used for swinging the derrick, which will cover three-quarters of a circle. The engines are of ample size to allow of raising of the load, raising the boom and swinging the derrick at the same time.

THE COST OF STEEL.

A Pittsburg newspaper quotes the following figures for the cost of open-hearth basic acid steel ingots at Homestead, claiming that they were taken from the books on Dec. 28th, 1889:

ACID OPEN HEARTH CHARGE.

Description.	Weight. Pounds.	Per ton.	Value.
Lucy special pig iron....	18,000	$23.56	$189.24
Bessemer crops.....	47,000	23.00	482.58
Bessemer cre, Republic..	2,000	7.85	7.01
Ferromanganese, 72 per cent.....	500	62.25	13.30
	67,500		$692.73
Total charge, tons....	30.13—$22.90.		

Products.

	Pounds.	Tons.	Per cent.
Ingots...	60,750	27.12	90
Scrap.....	2,700	1.20	4
Loss.....	4,050	1.81	6

Total cost of charge, $692.73, less value of scrap, $27, gives $665.73, actual cost of 27.12 tons of ingots, making the cost per ton of ingots.... $24.54
Labor..... ..... 1.65
Maintenance and repairs..... .42
Superintendence, clerical help and office expenses..... .... .37

Total cost per ton..... $26.98

BASIC OPEN HEARTH CHARGE.

Description.	Weight. Pounds.	Per ton.	Value.
Low-silicon pig..... ...	10,000	$20.16	$90.00
Cast-mill scrap.....	8,000	16.80	60.00
Miscellaneous wrought scrap...	12,000	22.40	120.00
Pit scrap.....	2,000	22.40	20.00
Iron ore.....	1,360	7.85	4.76
Ferromanganese...	240	62.72	6.72
Total charge..... ..	33,600		$301.48
Per ton.....			30.10

Product.

Total cost of charge, $301.48, less value of scrap, $13.46, gives $288.37, actual cost of 13.5 tons of ingots, making the cost per ton of ingots..... $21.36
Labor..... ..... 1.90
Maintenance and repairs..... .70
Superintendence, clerical help and office expenses..... .... .45

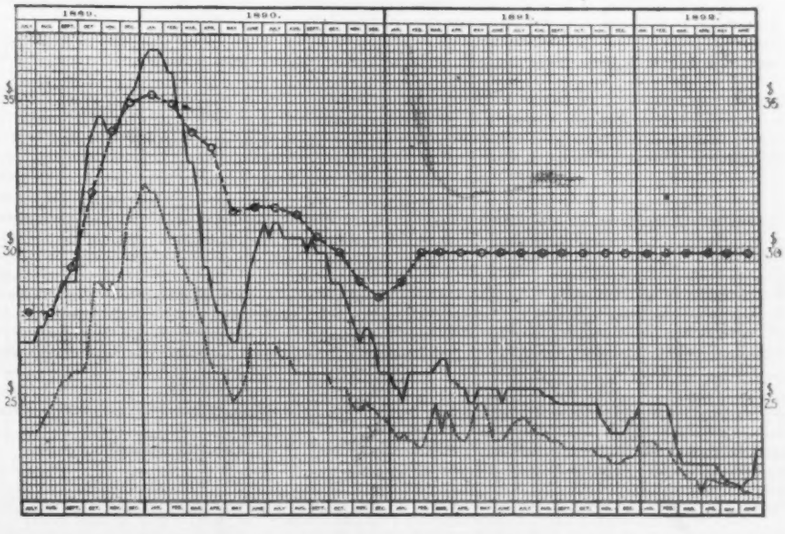
Total cost per ton..... $24.41

The "Iron Age," commenting on these figures, says:

These figures may mislead many. How little value is to be attached to them may be gathered from the fact that the fuel item is entirely missing. Natural gas, cheap as it is, costs something.

It would appear from the above, however, if at all reliable, that the labor charge is a small part of the cost of making the steel.

The same issue of the "Iron Age" gives a diagram showing the comparative weekly prices at Pittsburg of steel billets and of Bessemer pig iron, which we reproduce in a considerably modified form herewith, adding a third line to show the mean monthly prices of Bessemer steel rails at the mills in Pennsylvania, the last taken from the annual report of the American Iron and Steel Association. In order to reduce the size of the diagram and also to facilitate comparison between the prices of Bessemer pig and of billets and rails the price of the pig iron is plotted just $8 per ton too high throughout the diagram, so that where it reads $30 the actual price for the pig was $22, and similarly throughout the diagram. It will be seen that the price of the rails for the past year or two has been practically constant at $[illegible], and has not been affected by the fall in price of billets or Bessemer pig. How long this happy condition of things (for the manufacturers) will continue it would be hard to guess. As the number of independent producers is now very small it may continue for a long time, or the market may break any day, as has recently happened to beams. To pre-



FLUCTUATIONS IN PRICE OF STEEL BILLETS (FULL LINE), BESSEMER PIG (DOTTED LINE), AT PITTSBURG, AND STEEL RAILS (BROKEN LINE AND CIRCLES) AT MILLS IN PENNSYLVANIA.

(Bessemer Pig is plotted at $8 too high in order to bring the line within the diagram and to facilitate comparison.)

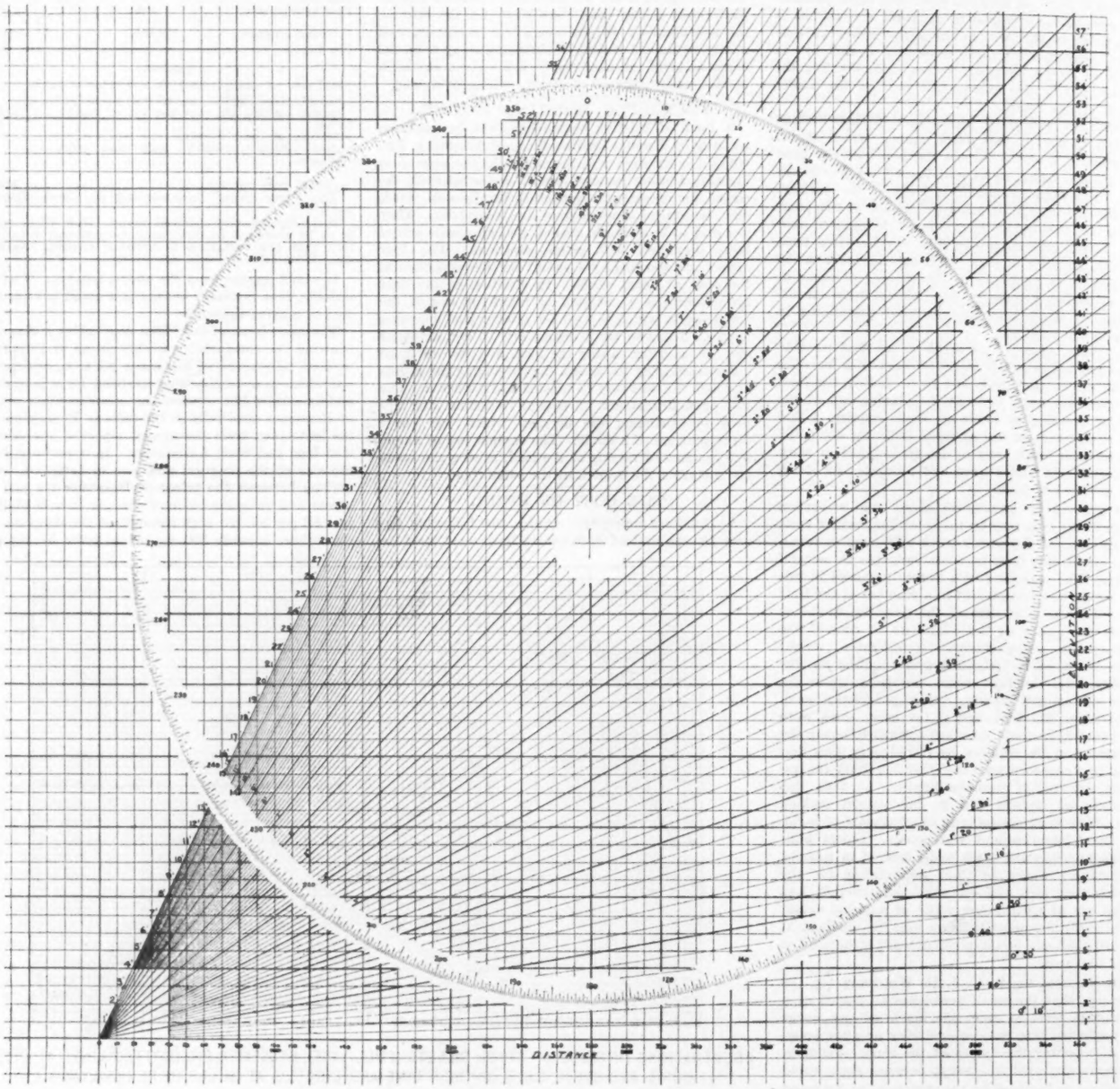
serve the same ratios as existed in 1889-90 the price of steel rails should fall to $25 or less.

FIELD SHEET FOR TOPOGRAPHICAL AND STADIA WORK.

We are indebted to Mr. T. J. McMinn for a copy of an ingenious combination of a protractor, stadia table and sketching sheet which is shown to half scale in the accompanying engraving, and which Mr. McMinn in an accompanying letter thus describes:

I send you herewith a field-table sheet which I devised last winter for use in some topographical surveys I was conducting with transit and stadia for Mr. Rudolph Hering. It is a combination of protractor, sketching sheet and stadia reduction diagram. Each of the three parts is well known, but I believe that the combination for the above purpose is original. The difficulty experienced in plotting horizontal angles in the field, especially in cold weather, by means of a metal protractor, induced me to have prints (black on white ground) made from a 14-in. engraved protractor printed on transparent paper. These sheets were attached to the field-table and the angles transferred by means of a parallel ruler. The vertical and horizontal lines were afterward added for convenience in sketching, and finally the problem of what to do with, or where to carry, the stadia reduction diagram in the field, was solved by drawing it also on the transparent sheet and making prints therefrom. Placed thus, it was accessible, and did not require rolling up and unrolling, and was not liable to be injured or lost. The form of the diagram is the same as that published by Prof. Johnson; and its scope, 12°, was merely sufficient for the work I was doing. The horizontal and vertical lines of the sketching sheet were utilized as the ordinates and abscissas of the reduction diagram. Distances were plotted by means of a scale graduated on the edge of the parallel ruler, and the ruler was also capable of being used as an alidade. The accuracy obtainable in plotting the horizontal angles was greater than with an ordinary metal protractor, and the difficulties and annoyances of plotting work in the field during inclement weather were greatly mitigated by this device. The scales used were 200 and sometimes 400 ft. to an inch, but the form of the diagram is adaptable to any required scale and could be modified to suit other conditions, such as vertical angles greater than 12°, etc., tc.

In practice the sheet was drawn with care on a sheet of tracing paper from which faint "black prints" were taken as often as required, at a cost of 10 cts. each. A much better way, of course, if sheets were wanted in any number, would be to have the whole sheet engraved on a plate and print therefrom direct. In this way any colored ink desired could be used; but even with the "black prints" the diagram lines were so faint that all the topographical mapping showed very clearly on it, as much so as if the ordinary cross-section lines had been the only ones on the sheet. It would, perhaps, pay some dealer in engineers' supplies to engrave such a plate and keep these sheets on hand.



FIELD-TABLE SHEET FOR PLOTTING TOPOGRAPHICAL SURVEYS.

The proposed expenditure of $6,000,000 at Cincinnati, for much needed water-works improvements, has been defeated by a popular vote of 20,263 to 9,706. The urgent need for improvements, which has existed for some time, is well known by hydraulic engineers. A large part of the pumping plant is defective and the supply of water is badly contaminated with sewage. Had the election resulted favorably the works would have been built under the direction of a non-partisan commission appointed a short time ago by the mayor. It is said that the scheme was defeated far more largely on political grounds than because the people did not wish to spend so much money.

NOTES FROM RECENT WATER-WORKS REPORTS.

The insufficiency of chemical analyses of waters as a means of determining their fitness for public water supplies is forcibly put by Mr. Willis P. Tucker, M. D., in connection with a report on chemical analyses of the water supply of Albany, N. Y., which appeared in the last annual report of the Water Commissioners of that city. Dr. Tucker says:

> Chemical analyses of potable waters may give us much valuable information as to the nature and extent of pollution, and the changes produced by natural agencies or artificial means, but they seldom justify us in asserting positively, either that a given water will necessarily give rise to disease, or will, with certainty, prove to be wholesome.

Several chemical analyses of water as supplied at Richmond, Va., are given in the last report of Superintendent C. E. Bolling. These analyses extend from 1873 to 1891. The latest analysis was of samples sent from Richmond Oct. 24, 1891, and was made by Instructor H. N. Ogden, of Cornell University. It showed, in parts per million gallons, 64 parts solids, 5.5 chlorine, 0.03 free ammonia, .01 part albuminoid ammonia.

The necessity of expending $6,000,000 for an improved water supply at Cincinnati, which sum the legislature recently authorized the city to appropriate for the purpose, is made apparent from a sanitary point of view by a recent report on the "Public Water Supply of Cincinnati," made by a committee of the State Board of Health. The committee concludes:

> (1). The present water supply of Cincinnati is dangerously polluted and should be abandoned as soon as possible. (2). The Ohio River above all local sources of contamination offers the best available supply; and. (3). this supply cannot be safely used without purification.

The statements regarding the quality of the present supply need no further proof than is given by the statistics of typhoid fever in Cincinnati for the past 25 years, there having been an average of 149 deaths from this disease during that period. The range of deaths has been from 58 in 1869 to 403 in 1887. In 1891 there were 188 deaths from the disease. In the census years 1870, 1880 and 1890 the deaths per 10,000 inhabitants were 4, 7 and 6.3, respectively. In 1887, assuming a population of 285,000, which is too high rather than too low, the typhoid death rate per 10,000 was 14.1, which is nearly as high as Chicago's alarming rate of 16.64 in 1891.

In addition to the proof furnished by the typhoid death rate 12 bacteriological examinations made by J. C. Oliver, M. D., from Oct. 2, 1891, to Feb. 18, 1892, show from 2,600 colonies of bacteria per 1 cu. cm. on Oct. 2 to 58,380 on Oct. 8. The average number of colonies found by the 12 examinations is 22,993 per cu. cm. The nature of the bacteria is not stated, but their numbers are high enough to cause alarm. Since the above was written the people by a large majority voted against issuing bonds for new works. Politics apparently caused the defeat of the project.

The annual reports of the Cincinnati Water Department always contain a large range of valuable statistics covering a large number of years. It is surprising to notice that the consumption of water in 1891 is reported as 199.67 gallons per capita as against 111.37 in 1890 and 99 in both 1889 and 1888. Only 4.2% of the services are metered, or 1,550 out of 36,754.

At Providence, R. I., as in many other cities, the consumption of water is increasing much more rapidly than the number of service pipes or distributing mains and far in advance of the population, as is shown by the following figures from the last report of the City Engineer, J. Herbert Shedd:

	Per cent.
Increase in average daily consumption since 1882..	98
Increase in miles of distributing mains.....	50
Increase in water services.....	53
Increase in population.....	16
Increase in water rents (several reductions have been made).....	48

The average daily consumption in 1891 was 7,272,070 gallons, or 50 gallons per capita on a basis of 135,000 population for the city and 10,000 for the suburbs into which the mains extend. Of the 15,723 services in use 9,972, or 63%, were metered at the close of 1891.

The report is accompanied by a map on a scale of one mile to the inch, showing the drainage area of the Pawtuxet River, from which the city's water supply is drawn. The map has contour lines and elevations. There is also a map showing the water-works system, including the pumping stations, reservoirs and mains, about 150 miles of 6-in. mains being omitted from the map.

The records of rainfall at Providence for the past 60 years, given in same report, show a remarkable increase in the total precipitation, the yearly average for each decade except 1872-81 being from 2.052 ins. higher for 1852-61 to 4.115 ins. higher for 1862-71, and the fall for 1872-81 having been but 0.401 in. less than that for the previous decade. The figures for the several decades, with decennial increase or decrease, are as follows:

Decade.	Rainfall, ins.	Increase or decrease, ins.
1832-41	37.970	.....
1842-51	40.763	2.793
1852-61	43.815	2.052
1862-71	47.930	4.115
1872-81	47.529	-0.401
1882-91	49.910	2.381

For the last half of the period, or from 1862-91, the average yearly rainfall has been 48.456 ins., against 40.849 ins. from 1862-91, the difference being 7.607 ins. Very detailed meteorological statistics for the year are given in Mr. Shedd's report.

Regarding the waste of water at Norwich, Conn., Superintendent E. P. Gardner makes some statements which are equally pertinent to many other cities and accord with the principles often laid down in these columns. He says:

> If the consumption of city water could be restricted to its legitimate use it would be equivalent to increasing our storage capacity one-third; for fully one-third of the water delivered is allowed to run into sewers and catch basins without serving any useful purpose whatever or doing any one a particle of good.

The location of hydrants and the pressure at each is shown by a map in the last report of the Water Commissioners of Madison, Wis. The same map also shows by various symbols the location of valves and the sizes of mains in each street. During the year only 409,000 gallons of water were pumped during fires, which for a city of some 14,000 inhabitants seems small. There were only 15 fires at which water was pumped. The total duration of these fires was 7 h. 15 min., or an average of 29 minutes each, the longest having lasted during 1 h. 30 min. and the shortest through 5 minutes. G. B. Heim is Superintendent.

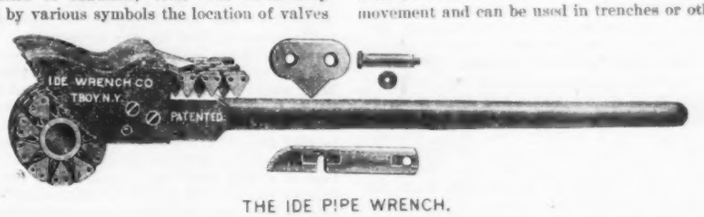
Water companies rarely print and distribute information regarding their works, unless it be when they wish to sell stock or bonds. A report from a company or a printed description of a company's works, like that recently prepared by Mr. J. P. Donahue, Secretary of the Davenport Water Co., of Iowa, is therefore doubly welcome. A few pages of text and several well executed half-tone engravings make up a very good description of the Davenport works, especial attention being given to the new 6,000,000-gallon American filtering plant.

THE SIMPLON TUNNEL.

The Simplon tunnel through the Alps will be the longest tunnel in the world, being 12.6 miles, or 3.1 miles longer than the St. Gothard tunnel. Work has been commenced. The northern portal will be near Brieg, in Switzerland, and the southern portal near Isella, in Italy. The northern portion of the tunnel will have a grade of 0.15% and the southern portion 0.65%. The process of boring will be the same as that followed with the Arlberg tunnel. Workshops are to be established on the right bank of the Rhone, close to the northern entrance, at a cost of $800,000. The power of the plant required is estimated at 1,550 HP., 520 HP. for boring purposes, 780 HP. for ventilation, and 266 HP. for electric lighting. This is for one end of the tunnel alone, for which purpose the river Massa is to be dammed to furnish water power. At the southern end a similar station is to be established, which is calculated to cost $600,000 and to furnish 2,760 HP., derived from damming the river Cairasca. The total cost of the remaining work is estimated at $16,000,000, of which $6,000,000 are contributed by the various states interested in the scheme. In order to facilitate the undertaking a track is to be laid on the road between Dornodossola and Isella. The Brandt rotary boring machines are to be used. It is calculated that the work will occupy 8½ years. By this tunnel the railway now terminating at Brieg will be connected with the railway system of northern Italy via Dornodossola, and a more direct and rapid route be established between Switzerland and northern Italy. The present well known road across the Pass is a very heavy one, running through the finest parts of the Alps. Constructed in 1800-1806 by order of Napoleon, at a cost of $3,600,000, its length between the two termini named is over 43 miles, its width 25 to 30 ft., and its average incline 3.5%, rising in zigzag to the highest point, 6,030 ft. Thence it declines in zigzag along water courses, past the villages of Simplon, Ruden and Crevola, to Dornodossola. The large number of guard huts, snow galleries and tunnels indicate the dangers attending this journey, which is generally accomplished by mail coach in 8½ hours. The railway journey will only occupy three-quarters of an hour.

THE IDE PIPE WRENCH.

We illustrate this week a form of pipe wrench of the chain pattern which is claimed to have many advantages over other forms of wrenches. The construction of the grip points gives it great strength, and it grips the entire circumference of the pipe, thus avoiding slipping or damaging the pipe. As will be seen by the cut, the chain is built up of staggered rows of cutters. The wrench is worked by a ratchet movement and can be used in trenches or other close places. It will reverse its grip perfectly and is not liable to break, being made from best steel and drop forgings. They are tested to 8,970 lbs. They are said to be in use on railway, conduit and subway work and in several locomotive and car shops, while negotiations are in progress for their export to France. They are manufactured by the Ide Wrench Co., of Troy, N. Y.



THE IDE PIPE WRENCH.

MAGNETIC AND NON-MAGNETIC PYRITES IN THE CROTON MAGNETIC IRON MINES.

The following is an abstract of a paper by Mr. W. H. Hoffman, presented at the meeting of the American Institute of Mining Engineers at Hotel Champlain, N. Y., in June, and in our issue of May 26 will be found an article upon the desulphuration of pig iron for Bessemer converters:

> During the autumn of 1891, several blasts (each throwing down some 3,000 tons of ore) were made, and immediately after one of these blasts the writer found that at least one-third of the ore was largely impregnated with pyrites, and besides this, fully 15% of the entire blast was composed of irregular lumps of magnetic pyrites. This was a revelation wholly unexpected, as previous examinations by many experts had failed to disclose any such quantity of sulphury ore. Over the center of the Theall tunnel there suddenly appeared a perfect keystone, as it were, of pyrites, 3 ft. wide at the arch of the tunnel, 13 ft. wide at the top, and 20 ft. high. This keystone pinched out in February, 1892, but in that month large blocks of pyrites were more plentiful on or near the western wall, and these deposits extended the entire height of the workings, some 43 ft.
>
> The second blast in November, in the face and over, and on each side of the tunnel, was far more surprising. The whole cross-section it exposed was thickly interspersed with layers of magnetic pyrites, ranging in thickness from 10 to 24 ins., and quite irregular in form, while all of the ore carried much more than the usual amount of sulphur in the non-magnetic pyrite; 155 tons from a portion of this breast (westward side), showed the composition, upon sampling and analysis, given in the first column, while that of the balance of

the blast is given in the second column of the following table:

	Per cent.	Per cent.
Metallic iron	45.080	33.210
Phosphorus	.304	.349
Sulphur	23.510	6.680

After a third blast, the scene was again transformed. A casual inspection showed that the large lumps of pyrrhotite were at this point located on or near the eastern wall, with one broad sliver, about 2 ft. thick, lying directly under the keystone before mentioned, which, by the way, had become smaller. Next to the sulphury keystone appeared another of lean ore and rock; and this rock has held up to the present time; though it is not now as wide as it was in the early winter.

Previous to the middle of October, 1891, it had not been necessary to reject more than 18% of the output in rock and sulphury ore, but the amount of such rejections gradually increased until in February, 1892, it had reached 39%. Had the roasting capacity of our plant been greater, we could have reduced this percentage materially, but we should thus have increased our fuel consumption. When we first started the plant, about three years ago, the sulphur in the ore roasted averaged 2.85%, and the cost of roasting under those conditions was less than 8 cts. per ton. For a long period we kept it at 9 cts., but in February of the present year, even after the rejection of from 34 to 39% of all the ore mined, the cost of roasting the remainder, so as to keep the sulphur in the concentrate below 1%, advanced to 13 cts. per ton.

Moreover, the richest ore gives us the highest sulphur. Our 37% crude ore now usually carries over 6% of sulphur; and any crude ore containing over 40% in metallic iron shows, on an average, taking the pile just as it is blown down, from 8 to 10% of sulphur. The ore from one room showed an unlooked-for amount of phosphorus, the analysis giving from 0.48 to 0.935%. A Hoffman separator, however, reduced the general average of 0.78 to .062% at one pass.

No other mines in Putnam Co. have shown half this irregularity in sulphur distribution; and this deposit, until late in 1891, was supposed to average less than 3.50% of sulphur in any form. All indications now point to an increase in sulphur, especially in the magnetic pyrrhotite, which has more than doubled in relative amount since the building of the concentrating plant. In some of the masses of pyrrhotite, streaks of rich magnetite have occurred from ½ to 1½ ins. thick; and clinging to the iron ore were thin sheets of apatite. The total ore contained by analysis, 41% metallic iron, 26.5% sulphur, 0.67% phosphorus. I have neither seen nor read of deposits just like the one here described; and I am told there are very few in the world that have as much sulphur in magnetic combination distributed so universally through the main bed of iron ore. Our only remedy for this new difficulty is, of course, more roasting, and every practicable reduction of milling expenses, to counterbalance the extra expense in roasting. The milling complete, delivering material ready for the separators, cost in February of the present year, 26 cts. per ton of concentrates, the average raw ore for the month containing a little less than 34% of metallic iron. It will now be necessary to reduce this item even below the figure reached in 1891 (22 cts.), because with the former rate of rejections (18% of the ore mined) we shall now have an average of over 6% in sulphur to remove in the roasters. We must therefore expect to spend at least 16 cts. on each ton of raw ore to reduce the sulphur to 0.7%, the highest sulphur mark now accepted by the Bessemer furnaces. It is the aim of the writer so to arrange a set of granulating machines that the desired economy in reduction shall be secured, but it will be several months before this matter can be decided. We have heretofore overcome many very serious obstacles, including some which appeared at first almost insurmountable; and we hope to be able to reduce our mining and milling expenses to an extent that will again put the plant on the road to success. Such a large body of ore deserves one more experiment.

In January and February of the present year, our mining cost us 46 cts. per ton for everything removed, the probabilities are that this cost can be reduced to 40 cts. wherever we quarry ore.

Tunnel and drift working could not be resumed, since the cost would be immediately raised to 90 cts. per ton, and this would of course exclude the possibility of profit under the circumstances. None of this ore, as it is now exposed, can be used without thorough roasting; and since its average in metallic iron, as it stands in the mine, is now fixed below 36%, it is worthless if it is not also concentrated. The mines have been closed until the necessary changes in the roasting and milling plant shall have been made.

PERSONALS.

Mr. L. W. Loehr has been re-elected as Surveyor at Walla Walla, Wash.

Mr. Bernhard Feind, M. Am. Soc. C. E., has opened an office in the Rookery Building, Chicago.

Mr. F. W. Hoyt, President of the Duluth, Red Wing & Southern Ry., died at Red Wing, Minn., July 13.

Mr. Robert E. McMath, ex-Sewer Commissioner, of St. Louis, Mo., has been appointed City Surveyor of that city.

Mr. Benjamin F. Cadbourne, of Biddeford, Me., has been appointed Railroad Commissioner, vice Mr. Roscoe L. Bowers, deceased.

Mr. H. W. Edwards has been appointed Engineer of Maintenance of Way on the Western Division of the St. Paul, Minneapolis & Manitoba Ry. (operated under contract by the Great Northern Ry.), with headquarters at Spokane, Wash.

Mr. W. S. Danes has been appointed Superintendent of Bridges and Buildings of the Eastern Division of the Wabash Ry., vice Mr. H. Dunlap, who was killed in a recent wreck on that road. Mr. Danes will have his headquarters at Andrews, Ind.

Mr. J. M. Floesch has been appointed Chief Engineer of the Clearfield & Mahoning branch of the Buffalo, Rochester & Pittsburg R. R., now under construction, with headquarters at Clearfield, Pa. Mr. Jonas F. Young will be Chief Engineer of the Johnsonburg & Bradford branch, vice Mr. Floesch, transferred.

Mr. Jos. P. Frizell has resigned his position as Engineer to the Board of Public Works, Austin, Tex. Mr. E. W. Grooves was then assigned to duty by the Board as Chief Engineer of construction of the dam, and Mr. N. Werenskiold, who has been employed by the Board as First Assistant Engineer since June 1, 1891, was assigned to duty as Chief Engineer of construction of the reservoir and the general water distribution system. The vacancy caused by Mr. Frizell's resignation will not be filled. Col. J. T. Fanning, of Minneapolis, Minn., has been retained as Consulting Engineer.

Mr. Thomas Nickerson, a well known railway man, died at Newton Center, Mass., July 24, at the age of 82. He was first interested in railway enterprises about 1873, when he became connected with the Atchison, Topeka & Santa Fe R. R. system, at a time when the road extended only to Emporia, Kan. Shortly afterward he was made president of the company and this position he held for five or six years. Under his management the road was pushed to its present western connections and termini, about 900 additional miles being built. He was next president of the Atlantic & Pacific R. R. and built its connection with the Southern Pacific Ry., and also built the Southern California Ry. to San Diego. About this time concessions were obtained from the Mexican Government for the construction of a road from the United States bonudary line through the state of Sonora to the Pacific Ocean, and another line from El Paso to the city of Mexico. The greatest of these enterprises was the Mexican Central Ry., 1,200 miles in length and costing $36,000,000. Mr. Nickerson had the confidence of so many large business men and capitalists that without the intervention of syndicates or bankers to raise the money, the necessary funds for this enterprise were secured, and the road was duly constructed to the satisfaction of the Mexican Government and great advantage of the two republics. Mr. Nickerson was for some years President of the Mexican Central Ry. Co.

NEW PUBLICATIONS.

DAS EISENBAHN GELEISE (RAILWAY TRACK.)—A Haarman, Generaldirektor des Georgs-Marien Bergwerks und Hutten Verein. 1891. Leipzig, Wilhelm Engelmann. Two vols., 8vo., pp. 852, 1,837 woodcuts in the text. $10.

Mr. Haarmann is well known as one of the leading German authorities on railway matters, and he has devoted much time to the investigation of the history and development of railway track, the study of which he has made a specialty. He was one of the first engineers to introduce the question of metal track for modern railways, and is the inventor of the Haarmann system of metal longitudinals, which is still in use to some extent in Germany. These few words will suffice to show the standing of the author. The book is one of great interest and value, the information having been collected and arranged with much care, and showing both by the illustrations and descriptions the growth and development of the modern track and track appliances. It is interesting to note the age of some devices, etc., which are from time to time brought forward, and sometimes patented, as novelties. The diagonal and scarf joints for rails, for instance, date back to 1816 and 1835. The book is a very fine specimen of typographical work, having clear type and first class woodcuts well printed on an excellent quality of paper. In accordance with a very general custom in Germany, there are only paper covers, so that purchasers can have the book bound to suit themselves. Rail sections are in solid black, and, with cuts of details, are generally to a scale of one-fifth; plans of track, etc., are generally to a scale of one-fiftieth; but the details of dimensions are rarely marked on the cuts. Dimensions are in some cases given in duodecimal as well as in metric measure. There is an extensive list of contents and a copious index.

The book is of course largely a compilation, and in that lies one feature of its importance, as it brings together and presents in proper order a mass of scattered information. Numerous reference footnotes are given to publications that have been consulted and quoted, which is an important feature not infrequently overlooked by authors of works of this kind. Among the American publications mentioned we notice Engineering News, the "Railroad Gazette," W. B. Parsons' "Track," Ringwalt's "Transportation Systems in the United States," Colburn and Holley's "Permanent Way," and E. E. R. Tratman's papers on railway track in the Transactions of the American Society of Civil Engineers and his report on "The Substitution of Metal for Wood for Railway Ties" made to the U. S. Government in 1890.

Vol. I, General History of Track (pp., 385; cuts, 894).—The arrangement of subjects is as follows: Introduction; Rails; Wood, Stone and Iron Ties and Longitudinals; Fastening of Rails to Ties; Rail Joints; Switches. The introduction begins with the wooden Roman roads of about the year 9, and describes the laying of wooden trackways for wagon wheels on the highways, 1620 to 1765, with the addition of cross timbers to carry the longitudinal planks or timbers, and the later use of iron strap rails on the longitudinals. Then come the cast iron angle, fish-belly and other early forms of rails, laid on wooden or stone blocks, etc., and the introduction of cast iron chairs fastened to the blocks and supporting the rail, which system has developed into the type of track which is now standard in England and largely used throughout Europe and elsewhere. Among the American railways are mentioned the old Quincy railway, the Jamaica R. R. (with pile foundation), the Camden & Amboy R. R. (with strap rails), and many other old lines, and the rails show the development from the Stevens T rail of 1830 (Eng. News, Nov. 2, 1891), to the modern heavy sections of the New York Central, the Pennsylvania, the Chicago, Burlington & Quincy, the Chignecto Ship Ry., and many other railways, in addition of course to the rails and track of numerous European and foreign railways. Details are given of weights, dimensions and dates of service. In regard to wooden ties, particulars are given of sections, size and material, cost, preservative processes and different methods of cutting from the log. In the part referring to metal ties, a large amount of the material has been taken from Mr. Tratman's report on metal track, above referred to, due credit being given for quotations. The Hartford steel tie of the New York Central R. R. is among those illustrated.

The chapter on rail fastenings describes various forms of spikes, bolts, screws, etc., for flange or T rails, with tie plates, rail braces, etc., for wooden and metal ties, and various methods of securing double-headed rails in the chairs and fastening the chairs to the ties. The Servis and other tie plates are shown. In this chapter are also given several forms of Mr. Haarmann's compound rails (divided vertically), with very wide flanges, designed to serve as a combined deep rail and wide longitudinal. The chapter on rail joints covers 108 pages and has 328 illustrations, including joints of early forms of rails and those in use in modern practice. There are a number of American joints, including the suspended, the three-tie supported, the long angle splice bars, the truss, the Fisher, and several patented forms, many of which have been illustrated in our columns. The Lehigh Valley R. R. suspended joint with six bolt angle bars and the rail ends cut diagonally, is also shown, and the beveling of the rail ends, as well as scarfing and halving them, is shown to date back on English and German railways to 1816, 1825 and 1835, and to have been practiced on some of the early American railways. Some of the German rail joints for track with metal ties and longitudinals are marvelous combinations and complications of tie bars, saddles, angle bars, tie plates, bolts, clamps and rivets. Forms of joint with Mr. Haarmann's deep and wide compound T rails are also shown. For flange rails in Europe the fish plate and angle bar joints appear to be the most general, the arrangement varying on different railways, and tie-plates or base-plates being used in several cases. On some of the German lines the splice-bars are extended up against the outside of the rail head, as in the old splice bars still in use to some extent on the New York, New Haven & Hartford and Delaware & Hudson railways. Several of the old joints present familiar features which are seen over and over again in modern patented forms of joints. The chapter on switches commences with a notice of the crossing of grooved trackways in stone roads built by the old Greeks, and the switches on angle-rail tracks in 1797, and then follows the development of the stub and split switches in different countries, showing the American split switch with spring attachment to prevent damage by a train trailing through a closed switch.

Vol. II. History of Track (pp., 467; cuts, 943).—The

arrangement of subjects is as follows: Wooden Blocks, Wooden Longitudinals, Stone Blocks, Wooden Cross-tie System, Iron Blocks, Iron Longitudinals, Rails Forming Their Own Bearing Surface, Gage, Railway Construction, Ballast and Drainage, Maintenance and Repairs. This volume opens with details and cuts of the tracks of early railways, beginning with an English fish-belly rail of 1790, and including those of several American lines, some of which are interesting as showing the early idea of securing a rigid track by the use of stone foundation. A track of the Baltimore & Ohio R. R. of 1845 is shown, consisting of bridge rails on longitudinal timbers resting upon cross ties, which in turn rested upon other longitudinals. The rails were secured by bolts and spikes, and rested on tie plates at the joints and some intermediate points. The modern English bridge-rail tracks of the Great Western Railway and the Forth Bridge are also shown. An early track of the Philadelphia & Reading R. R., 1844, had cross-ties laid at an angle of 45° resting upon other ties laid at right angles with them. The early stone supports are also shown, including the Boston & Lowell track, 1829, with stone blocks and stone cross-ties. The wooden cross-tie system is then taken up, showing the development up to 1890 of the present standard English system of track, which is used extensively in other countries and consists of double-head or bull-head rails carried in iron chairs which rest on cross-ties. The flange or T rail track is then taken up in the same way, and details given of various American and European tracks, with different forms of fastenings and joints. The Orleans Central Ry., 1859, had a singular fish plate joint or pear-shaped rail, in which the fillets of head and base were cut away for the length of the fish plate, so as to give a more nearly horizontal bearing and to give also an end bearing for the plate. Three bolts were used, the middle one passing through the notched ends of the rail webs, an arrangement which is in use on one of the railways in India.

Coming down to modern tracks, there are shown those of several European railways, including the Belgian State railways, with 100-lb. Sandberg rails (Eng. News., July 18, 1891). The six-bolt angle bar joints of the Pennsylvania R. R. and New York Central R. R. are illustrated. About 170 pages are then devoted to metal track of various kinds, including many now in use, and showing the Hartford and Standard steel ties used in America. The metal longitudinal systems, mainly used now in Germany, are in general very complicated, especially at the joints, as already noted. Several of Mr. Haarmann's designs of metal longitudinals are shown, including that of the elevated Berlin City Railway, which has, however, been abandoned on account of the noise (Transactions Am. Soc. C. E., December, 1891). A number of designs are shown of rails intended to afford their own bearing surface, including the Barlow rail, with its wide flaring sides, the Hartwich flange rails of 11 ins. height, and Mr. Haarmann's compound rail consisting of two halves of a flange or T rail (divided vertically), which when riveted or bolted together form a rail 6 to 7 ins. high and 11 to 13 ins. wide over the base. This closes the part of the book which refers to the track proper.

An interesting chapter on railway gage is then given, showing how greatly this varied in the early days of railways, and what methods were adopted for interchange of traffic when the extension of railways brought the various gages into contact and conflict. It is stated that in 1870, 4,000 miles of broad gage railway in the United States were saved from bankruptcy by laying a third rail or narrowing the gage to secure interchange of traffic. The widening of the narrow gage of the Denver & Rio Grande R. R. is also referred to. From the details given we have compiled the following table showing the gages now in most general use in the several countries of the world, and it is stated that of all the railways in the world, 74% have the standard gage of 4 ft. 8½ ins. (including those of such slight variation as 4 ft. 9 ins., which allow of through traffic of rolling stock), 12% a broader gage and 14% a narrower gage.

Table of Railway Gages.

England, Germany, Austria, Switzerland, France, Italy, Denmark, Netherlands, Belgium, Roumania and Turkey	4 ft. 8½ ins.
Ireland, (some narrow, 3 ft.); standard	5 ft. 3 ins.
Spain and Portugal	5 ft. 6 ins.
Russia	4 ft. 8½ ins. and 5 ft. 0 ins.
" Transcaucasus	5 ft. 0 ins.
Sweden, four-fifths, 4 ft. 8½ ins.; the rest 4 ft. and 2 ft. 7½ ins.	
Norway, two-fifths, 4 ft. 8½ ins., the rest	3 ft. 6 ins.
United States and Canada,	4 ft. 8½ ins. and 4 ft. 9 ins.
Mexico	4 ft. 8½ ins. and 3 ft. 0 ins.
Brazil, 2 ft., 3 ft. 3⅜ ins., 4 ft. 7 ins., 4 ft. 8½ ins., 5 ft. 3 ins.	
Argentine Republic	5 ft. 6 ins.
India, 5 ft. 5⅝ ins., 5 ft. 6 ins., 2 to 4 ft., 3 ft. 3⅜ ins.	
Ceylon	5 ft. 6 ins.
Java	3 ft. 6 ins.
Japan	3 ft. 6 ins.
Asia Minor	3 ft. 7¼ ins.
China	4 ft. 8½ ins.
Africa: Egypt, Algeria and Tunis, 3 ft. 7½ ins., 4 ft. 8½ ins.	
Africa: South African colonies and new Central Africa line	3 ft. 6 ins.
Africa: Mombasa and Taveta line	2 ft. 0 ins.
" Dar-es-Salaam and Bagamoyo (projected)	1 ft. 11½ ins.
Australia: New South Wales	4 ft. 8½ ins.
" Victoria	5 ft. 3 ins.
" South Australia	3 ft. 6 ins., 5 ft. 3 ins.
" Queensland	3 ft. 6 ins.
New Zealand	3 ft. 6 ins.
Tasmania	3 ft. 6 ins.

A general chapter on railways gives particulars of early practice and experiments in regard to grades and curves and their operation by locomotives. Also particulars of cuts, tunnels and other construction works, the first railway tunnel being near Liverpool, England, on the Liverpool and Manchester railway. The use of parabolic curves is said to be increasing in Germany and other countries. The next chapter, on ballasting and drainage, is by no means the least interesting or important. Beginning with the stone and wooden ties on a broken stone foundation, it follows the gradual development of modern practice and illustrates a variety of modern roadbeds, including the Pennsylvania R. R., with gravel, and the New York Central R. R., with broken stone. Some of the German railways have a very elaborate construction of roadbed, with rubble drains, tiles, trenches filled with broken stone, etc. The arrangements of tracks and foundations for street railways are also shown. The concluding chapter is devoted to tracklaying, maintenance and renewals, and gives tables of the work and cost of renewals on some of the German railways. It also deals with the curving of rails, the preparation of ties by boring for fastenings, etc., and refers to the quick work of tracklaying and the use of tracklaying machines in the building of new railways in this country.

The scope and character of this book will be seen from the above review of its contents, and we have considered it of sufficient value and importance to warrant this rather unusually long review.

IOWA SOCIETY OF CIVIL ENGINEERS AND SURVEYORS.—Proceedings of the fourth annual convention, held at Burlington, Ia., Dec. 29 and 30, 1891. 8vo., pp. 91.

In addition to the minutes, committee reports and president's address, there are the following papers: "Calculation of Average Haul," R. G. Brown; "Permanent Reference Marks," C. W. Bisbee; "Title by Adverse Possession," Seth Dean; "Economy of Wood vs. Iron for Truss Bridges in Iowa," E. M. Gilchrist; "Clays for Paving Brick," Wm. Steyh; "Tide Lands," A. B. Little; "Correction of Earthwork Estimates, Measured by Averaging the End Areas," R. G. Brown; "Needed Legislation," M. V. Ashby; "Perpetuating Surveys," D. O. Potter; "The Problem in Race Tracks," R. G. Brown; "Cost of Earthwork," J. M. Brown; "Iron and Steel," Garrett Davis.

SOCIETY PROCEEDINGS.

ASSOCIATION OF ENGINEERS OF VIRGINIA.—The regular meeting was held in Richmond July 4 and 5, Mr. Wm. H. Adams in the chair. The session was opened by the reading of the address of the President, Mr. Clarence Coleman. The following papers were read during the session: "The Necessity of Co-operation by American Engineers," Mr. T. W. M. Draper; "A National Railway College," Mr. Herman Crueger; "Easement Curves," Mr. Chas. H. Rice; "A Plea for the Establishment of a United States Weather and Signal Station at Roanoke," Mr. Chas. H. Churchill; "Construction of the Iron Coal Pier of the Norfolk & Western R. R. at Lambert's Point," Mr. W. W. Coe; "Historical Notes Bearing Upon the Work of the First Mining Engineer of the Colony of Virginia," Mr. Wm. H. Adams. The Committee on the Improvements of Highways in the state presented its report, but it was referred back. This subject will again come up for discussion at the next regular meeting.

James R. Schick, Secy.

ENGINEERING ASSOCIATION OF THE SOUTH.—The regular meeting was held at Nashville, Tenn., June 9. Vice-President James Geddes, Presiding. The paper of the evening, entitled: "Notes on Mine Surveying," was read by Mr. Benjamin W. Robinson, Mining Engineer of the St. Bernard Coal Co., of Earlington, Ky. The paper called attention to the rapid advances in mining during the past few years and in the general adoption of more scientific methods; and showed that the work of mine surveying had not received the attention its importance warranted, either in standards of precision or in reliability of results. Tunnel surveying has reached a high state of perfection simply because of the high standards demanded. The author considered as essential to good work the following outfit: the complete mining transit arranged for vertical sighting and provided with extension tripod, vertical circle with bubble on telescope and stadia wires for outside topography, also a sensitive needle for checking vernier angles. Steel tapes should be used for linear measurement and plummet lamps for sighting. The old compass and the link-chain should be discarded for mining work. The author outlined a system for an underground survey with manner of connecting it with the surface system; important points in the underground system should be duplicated on the surface and monumented.

At the meeting on July 14, Col. H. M. Robert, U. S. A., presiding, Mr. W. W. Carson, of Knoxville, read a paper on the Mississippi River problem. He suggested that every interest in the nation, and indeed in the civilized world, would profit by the solution of it. To establish his points he quoted from Capts. Leach and Kingman and others. He spoke briefly of the caving in of the banks of the Mississippi River by the acre; of the vast amount of silt borne by the stream while in flood; and of the heavy deposits which occur where current is retarded. The high water current often flows across the low water channel, and where this occurs, the deposits of silt often entirely fill up the low water channels. The bed of the river is not fixed; cut-offs, measured by tens of miles, sometimes occur, and the river at places shifts itself sideways more than a thousand feet in a single year. Any effective solution of the navigation problem would incidentally furnish perfect protection from floods. Failures in levees are due to lack of size. Levees, built too small for lack of money, were not reinforced, since the next year's taxes had to be used in replacing levees caved into the river. To secure good navigation the river must be forced to flush itself by flowing always along the same channel. This could only be brought about by levees, and these must be placed right on the banks. Some people might ask about the water-way, but those who knew the river, and had seen it carve new channels of its own volition, could never doubt it would give itself all needed water-way by going down, if kept from going sideways. Since the levees should be placed on the banks, the caving should be prevented. Moreover, the holding of these banks would cut off the supply of detritus and this, of itself, would almost arrest further shoaling. This then is the key to the problem. Only two ways of holding caving banks are so far known; that of carpeting the submerged slope with mats of brush, and that of building huge spur-dikes 500 or 1,000 ft. apart. Both processes are very costly, and so another method is much to be desired. The author proposed a plan which he thought would reduce the cost by 30%, or even more. In building a spur-dike, he proposed to use large wooden crates, trussed like a bridge, about 50 ft. long and 10 or 12 ft. wide and deep. After weighting each of these with about 30 yds. of earth, he would sink them, during low water, with their lengths parallel to the current, thus building the spur-dike of the desired size and shape. He claimed that the current, in passing through these crates, would be so retarded by the chords and braces and by the chamber containing the earth used for sinking, that it would fill the crates with silt. He said that a block of silt measuring 50 ft. in the direction of the current could not be moved by any current of the Mississippi. Trusses of crates to be used in exposed positions might be made plate girder like, to prevent the washing away of deposited silt. He favored, however, another kind of protection. He would build a series of pavements, about 50 or 100 ft. apart, measured with the current across the submerged slope of the bank. These pavements should be made of blocks of silt 50 or 75 ft. long, placed parallel to the current, as in the other case. These blocks, likewise incased in trussed crates, should be about 5 ft. deep and 16 ft. wide. He exhibited blue-prints showing how these crates could be framed and put together with wooden pins alone, and showing a spur-dike and a pavement made of the crated blocks of silt.

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Aug. 5. Secy., E. K. Smoot, 508 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Aug. 5. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Aug. 6. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Aug. 6. Union Station, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
Aug. 8. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Aug. 8. Secy., C. L. Annan.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Aug. 11. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Aug. 11. Secy., O. H. Landreth, Nashville, Tenn.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 18. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Aug. 18. Secy., C. F. Franson, 113 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
Aug. 19. Secy., J. F. Wilson.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Aug. 20. Secy., F. D. Jones, Helena.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3. 1122 Girard St. Secy., L. F. Rondinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York.
WESTERN RAILWAY CLUB.
Sept. 20. Bookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., E. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Defective axles on some of the engine and tender trucks of the American ten-wheel locomotives built for New South Wales have been used as an argument against American workmanship and materials by the colonial opponents of these engines, as noted in our issue of July 21. These opponents were in favor of English built engines, but as far as the axles are concerned it is possible that even worse results might have been obtained with those of English make, since some engines recently built in England for India have had bad failures of driving axles. According to "Indian Engineering" there have been five cases of failure of engine axles on the Bhavnagar, Gondal, Junagad & Porbandar Railway during the past 12 months. The first case occurred in May, 1891, when the driving axle failed on an engine which had only run 35,298 miles out of the guaranteed 150,000. Since then there have been four other failures, fortunately without any serious mishap. The engines were all supplied by Neilson & Co., of Glasgow, most of them as late as 1888, and in most cases had not run even half the guaranteed mileage. It is not stated whether these engines had inside or outside cylinders, but if the former, it is quite likely that the crank axles failed under heavy strains due to imperfections in the track of this comparatively new road. Crank axles are not reliable, even on English roads with substantial and well kept track, and are certainly not adapted for locomotives running on a rough track. It is, of course, unfortunate that some of the truck axles of the New South Wales engines failed soon after being in service, but it would be as absurd to base a condemnation of American locomotive construction upon this one point as it would be to base a general condemnation of English locomotive construction upon the failure of the axles of the Indian engines.

The great question of whether or not to fill in the Harlem River between Third and Eighth Aves., and thus make New York a peninsula instead of an island, was up before a Board of Engineers last week, and a public hearing was had on nine questions recently propounded by the Senate Committee on Commerce. It was developed in evidence that such filling in would create 235 acres of land, or 3,762 city lots, worth about $10,000,000, it was claimed, and adding to the value of real estate on both sides of the Harlem "fully $100,000,000." The railways and the large property owners do not appear to have been represented at all, and certainly were not in opposition, but various small local interests were represented by loud opponents of any change in the status quo, as was to be expected. For example, the owner of a small naphtha launch works on the stretch in question, declared that "his business would be ruined" by such a change, forgetting to consider that a few thousand dollars would move his one-story, wooden buildings and their contained plant to some other point on New York's vast unoccupied water-front, and only to that extent was either he or the city interested in that part of the question. Mr. Geo. S. Greene, Jr., Chief Engineer of the Department of Docks, entered an "emphatic protest" against filling in any part of the river, to our great surprise. Perhaps he felt it to be his official duty to do so, but we should not have expected it of him. The crucial test on this question is: Had the Harlem River never existed between Third and Eighth Aves., would a proposition be considered to cut a large ship canal (not a small canal for unmasted boats) through the flats where the river now is? No practical and sober business man would seriously consider such a proposal under such conditions. In fact, the greater portion of Brooklyn would now be planted on and above that area, and cutting the canal would long since have been out of the question. Therefore, we regard it as only a question of time when the river will be filled in solid, barring a possible narrow canal for low boats.

CONCEALMENT OF THE SANITARY CONDITION OF CITIES.

The instinct of the ostrich, which thinks that if its head be only hidden its body will also be invisible, seems to be shared by a good many men. Some city officials and daily newspapers seem to think that in matters relating to the city's health their duty is not so much to take all possible measures to render the city healthful as to make the outside world think that the sanitary conditions are all that can be desired. Thus, when the first disclosures were made regarding the very high death rate from typhoid fever in Chicago for the year 1891 the City Health Commissioner, it is reported on good authority, vehemently denied that there had been anywhere near 2,000 deaths from the disease in the city in 1891. But an examination of the mortality returns proved that there had been within three of the number of deaths named, or 1,997. Some of the newspapers of Chicago have acted and still act on very much the same principle as did this official.

Another attempt to keep up a reputation for good sanitation, even if the effort closed the avenue by means of which public opinion could most easily be reached and influenced, has for some time been going on at Burlington, Vt. Owing to the smallness of the place and its natural healthfulness, of course the needs for sanitary reform have not been so great as in many other localities, yet the prosperity of the city depends in an unusual degree upon its reputation for healthfulness, and the plainest dictates of prudence require that this reputation should be carefully guarded.

The situation in brief is this: A public water supply was introduced by the city in 1867, and the first sewers, of any length at least, were put in use in 1875. The water supply is pumped from Lake Champlain, or from Burlington Bay, on which the city is built. The intake pipe extends out only some 50 or 60 ft. from the dock line. For 10 to 12 years after the sewers were put in a considerable part of the sewage was discharged at the dock line, only a few hundred feet from the water-works intake. The evil of this course being at last comprehended, about five years ago an intercepting sewer was built which, since that time, has carried the city's sewage to a point about three-fourths of a mile from the water-works intake, discharging it so near the shore that when the lake is low the discharge has not been under water.

Through all the years since the sewage was first discharged into the lake several citizens and some of the most prominent local physicians have objected to drawing water from a point so near the sewer outlet. The successive health officers have been some on one side, some on the other. It has been urged that there has been a strong and constant current which takes the sewage as it discharges into the lake in a direction opposite to the suction pipe and thus prevents any possible contamination of the water supply. However this may be, it is evident that much of the sewage is deposited on the bed of the bay, to be stirred up and distributed through the water during storms. Moreover, a breakwater about a half-mile from the shore shuts in this part of the bay, forming a large basin in which the greater part of the solid matter in the sewage must remain. In addition, the city being on the side of a hill, and not all of the storm water entering the sewers, considerable surface drainage of an objectionable character must find its way into the lake. Altogether the water supply is not only in danger of pollution, but analyses have shown it to be slightly polluted.

For some years an effort has been made to secure a better supply; but those furthering this effort have found it difficult to reach the public ear, owing to the fact that the only daily paper in the city has seemed to be much averse to publishing anything which might detract, for the time, from the city's reputation for healthfulness, or possibly because it did not wish to see any great expenditures for a new supply, although it seems to favor the proposed change noted below.

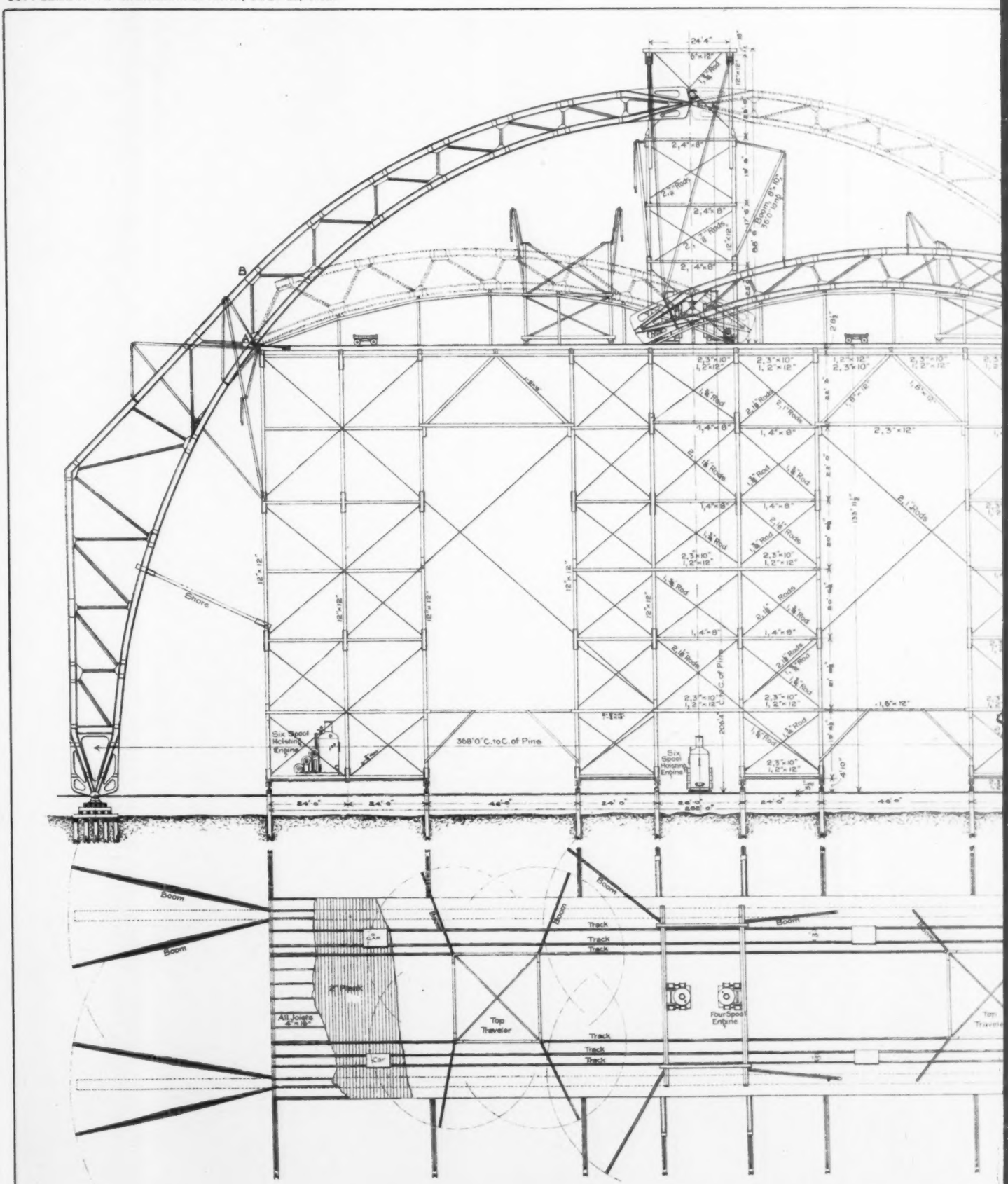
Recently the Water Commissioners reported to the Board of Aldermen in favor of a new supply. After referring in a general way to the possibilities and probabilities of the contamination of the water supply by sewage, and stating that while there has not seemed to be just cause for alarm in the past there is a menace for the future, the commissioners give a few particulars designed to show the need of a change. These statements should have been brought before the public, instead of being suppressed, as they were by the Burlington "Free Press." A weekly paper published in Burlington, the "Independent," gave the report in full. Seeing the report in each paper and noticing a line of asterisks at a significant point in the report as given in the "Free Press," an examination of the report as given in the "Independent" showed that the following had been omitted by the other paper:

> For the past few years the volume discharged from the city sewer has, owing to extensions in the system, increased very rapidly, and this will continue to be the case for some years to come. With increased volume comes increased opportunities for gathering and forwarding germs of disease. The sewage of the Fletcher Hospital has but recently been turned from the Winooski River into the city system. Whether this increase in volume of sewage has had anything to do with the slight increase in the percentage of mortality from zymotic diseases, which has occurred in spite of the discontinuance of the College St. outlet, it is impossible to state.
>
> That the facts in regard to the spread of infectious diseases in the past do not more strongly confirm the theories, so graphically and oftimes convincingly advanced, relative to the continuous current maintained by means of water and sewer pipes in our city, is undoubtedly largely owing to the fact that in the past there has been a large receiving or settling basin at the mouth of the sewer, from which under ordinary conditions but a very small per cent. of the bacteria of raw sewage go forth alive.

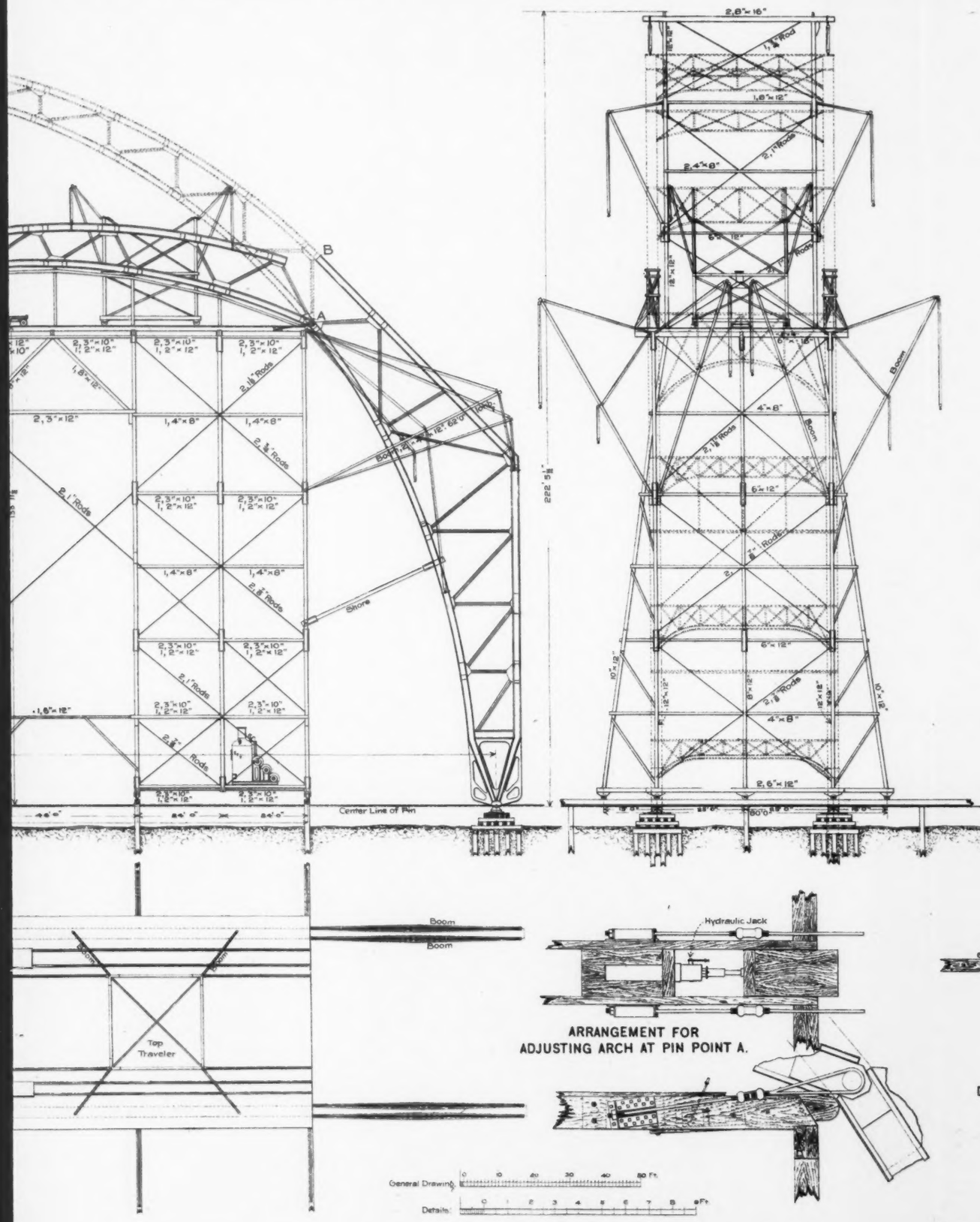
Why should a newspaper thus withhold from its readers the words intended by a body of officials to convince the public that a change in the source of water supply is demanded if the health of the city is to be maintained at its present standard? The most probable motives can be most forcibly expressed by the words cowardice and a false view of economy; cowardice because it is feared that the truth may keep some people and money away from the town; false economy because the money needed for improvements alone is considered, while the cost of sickness and lives lost and of money driven away from the town because of unhealthfulness is not considered.

If Chicago and Burlington were the only two cities whose newspapers and health officers at times tried to hide rather than to make known and to remedy unsanitary conditions these comments would be far less necessary, but unfortunately the same foolish motives actuate a good many papers and people in many other cities.

If the attempts noted were only to hide the real conditions from the outside world there might be some slight excuse on the plea of self-defense and human weakness; but such an excuse cannot be urged when newspapers, the self-constituted guardians of a city's prosperity, and health officers, the legally appointed guardians of its health, unite to conceal dangers from citizens instead of giving warnings of them.

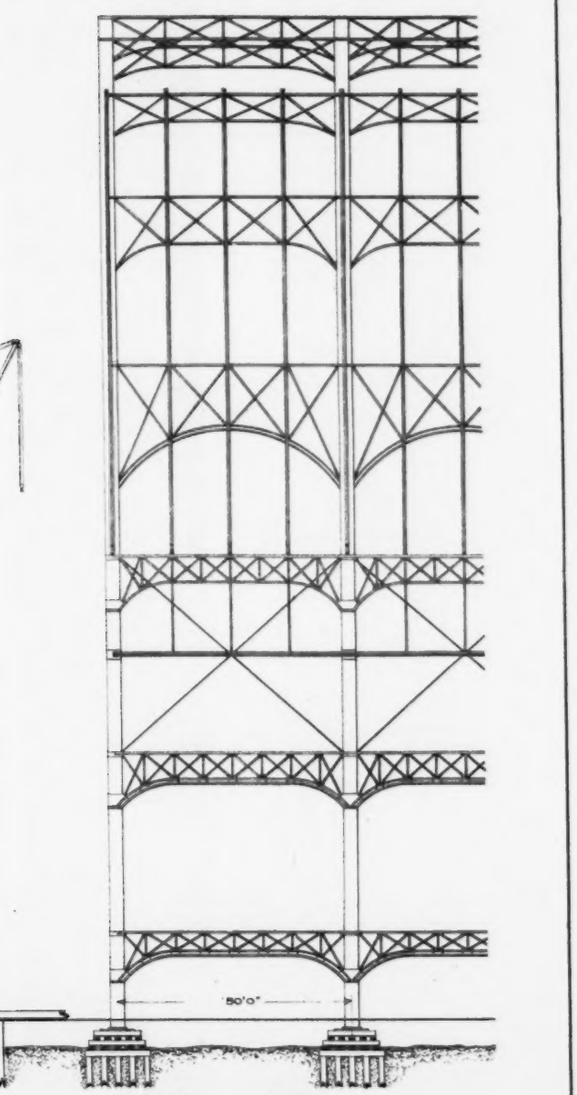


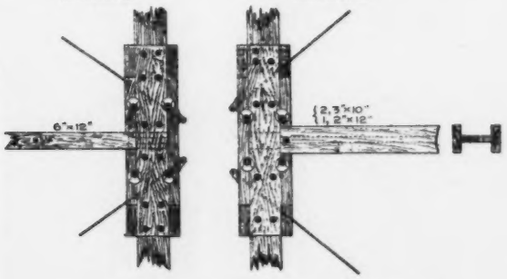
TRAVELER FOR ERECTING TRUSSES OVER MAIN COURT OF MAN
Edge Mo



COURT OF MANUFACTURES AND LIBERAL ARTS BUILDING; WORLD'S COLUMBIAN EXPOSITION.

Edge Moor Bridge Works, Builders.





DETAIL OF SPLICE AND JOINT IN MAIN POST.

N.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

THE RAILWAY RECORD OF 1891.

The advance sheets of the introduction to the year'y issue of Poor's "Railroad Manual" are always awaited with interest, as giving the first available summaries of the results of railway operations during the preceding year. They are generally issued about the middle of the year, and purport to cover the preceding calendar year, but as they have to accept the reports for whatever fiscal year each company may choose to report, the aggregates do not cover any one year accurately. The average year which they cover ends about Sept. 30, or some nine or ten months before each yearly volume is published. Still, they come out a long time before the reports of the Interstate Commerce Commission, which so far have not appeared until 18 or 20 months after the end of their fiscal year, and hence are of much more interest, so far as they go. The interstate reports give a good deal of information which Poor does not, however, so that the yearly issue of Poor no longer has quite as great importance as before the collection of official statistics began.

The advance sheets appear this year somewhat earlier than usual, but somewhat late in the week, as well as in a very hot week. It is quite too hot for us to attempt to analyze the report with the care that we should use under more favorable circumstances. Our readers would not take the trouble to read any very elaborate analysis if we took the trouble to make it for them. The most important figures only we lay before them on another page, and beyond this we content ourselves with a still briefer summary of a few of the more salient facts only.

The mileage increase of railways in 1891 is placed by Poor at 3,899 miles, against 5,349 miles the year before, these figures substantially agreeing with those we reported soon after the beginning of the year. The total on Dec. 31, 1891, is given as 170,601 miles, of which 167,909 miles was "completed up to the close of the fiscal year of the respective companies" and is reported in respect to assets and liabilities, while 164,262 miles only have their operating statistics also given. This is coming very close to a full report. Even the interstate statistics have not yet succeeded in coming any closer to a full report. The omissions would affect the totals but little.

The total mileage of "second track and sidings" is given as 46,683 miles, or 27¾% of the main track mileage. This figure, we are confident, errs largely by omission; besides which, second track and sidings should not be lumped together but given separately. The increase in second track and sidings is given as only 1,890 miles. The reported mileage of steel rails is now given as 174,931, or some 10,000 miles more than the total mileage of railways whose operating statistics are given. As the total of second, third and fourth track in the United States is also about 10,000 miles, according to the last interstate report, we may say in a general way that all our main track is now laid with steel, the little which is still laid with iron being balanced by an equal amount of sidings laid with steel. The percentage of the total track laid with steel has increased as follows since 1880:

1880.	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91
29	37	47	53	58	61	63	68	72	75	80	82

The comparative and absolute increase in number of locomotives and freight cars since 1877 is really a very striking exhibit, as showing how rapidly traffic has increased and with it the average train load. This becomes especially clear if we deduct from the total number of locomotives the number used in passenger service (which is shown by the interstate reports to be about one locomotive for each 3.4 cars). Making this separation we obtain the following interesting exhibit of the increases in rolling stock and rolling stock efficiency since 1877. For the sake of brevity we give every third year only down to 1889:

	1877.	1880.	1883.	1886.	1889.	1891.
No. passenger cars	12,053	12,789	16,889	19,252	22,885	24,497
Total number locomotives	15,911	17,949	23,623	26,415	31,041	34,022
Of which, passenger locomotives	3,340	3,760	4,965	5,655	6,740	7,209
" freight locomotives	12,571	14,189	18,658	20,760	24,301	26,822
No. freight cars	392,175	539,255	778,663	845,914	1,051,169	1,410,304
do. per freight locomotive	31.2	38.0	41.7	40.5	43.1	43.9

The apparent increase in the efficiency of each freight locomotive since 1877 is here 37½%, but this alone is a very imperfect measure, for the reason that each freight car carries a vastly heavier load now than in 1877. This we may see in part (i. e., since 1883 only) by taking the following figures of ton mileage from another table, and computing the ton-miles made per freight car:

	1883.	1886.	1889.	1891.
Ton-miles hauled, 1=1,000,000	44,065	52,802	68,677	81,210
Ton-miles per fr't car	56,600	62,400	65,400	73,250

Here is another gain in the efficiency of each car of nearly 30% in eight years, besides the gain of 37½% above in number of cars hauled per locomotive. The total gain thus made is $1.30 \times 1.375 = 78\frac{1}{2}\%$, which would be still larger if we were to carry the comparison of ton-miles hauled as far back as to 1877.

This continual lowering of the cost of transportation by increasing the efficiency of the transporting plant is something of which we may be justly proud, as it is quite without parallel in any other part of the world. That the process still continues is abundantly shown in this report, and is one of the most interesting and truly important facts shown in it.

In Table 2 elsewhere we show this fact at length

	New Eng. 1882.	New Eng. 1891.
Av. haul, miles	58.7	68.6
Av. rects. per ton, cts.	99.9	93.2
Do. per ton mile, cts.	1.70	1.36
Do. per train mile	$1.59	$1.61

for each section of the country separately, by reprinting the substance of some new and interesting tables making comparisons for ten years past for each of Poor's eight groups of states and for the United States as a whole. The facts are so significant, however, that we condense some of those in regard to average train load as follows, and add a little table of percentages; advising every reader, however, to look over the full tables also:

Average Freight Train Load in Tons.

	N. Eng.	Midd.	No. C.	N. W.	So. Atl.	So. C.	S. W.	Pac.	U. S.
1882	93.3	181.3	134.5	112.0	83.0	49.3	101.7	119.2	128.8
1886	113.2	175.9	151.1	15 .2	116.7	129.8	122.2	144.9	151.0
1889	118.2	191.3	167.2	148.5	130.4	142.2	120.3	137.7	159.9
1890	120.7	191.1	16 .5	150.7	143.1	150.0	133.1	142.8	164.0
1891	118.3	199.7	163.3	16 .5	155.7	148.7	126.2	143.4	164.6

Increase Per Cent. in Train Load.

	N. Eng.	Midd.	No. C.	N. W.	So. Atl.	So. C.	S. W.	Pac.	U. S.
1882-91	26.8	10.1	21.4	43.2	87.5	202.0	24.1	20.3	27.8
1886-91	4.3	13.5	8.1	3.4	33.3	14.6	3.3	—1.0	9.0
1889-91	0.1	3.3	—2.4	8.1	11.8	3.1	4.9	4.1	3.9

With two trifling exceptions, which prove the rule (and which are plainly due for the most part to imperfections of the statistics), it will be seen that in every group there has been an almost steady increase in freight train load which still continues at the rate of somewhat over 2% a year at least, and in some groups 3% a year or more. The mean trainload in the North Central group has apparently decreased a little in the last two years, but then the train load in the adjacent Northwest group has increased in much greater proportion. As several of the great systems lie in both of these groups, the explanation of this discrepancy is simply that the ton-mileage made in each was not quite correctly distributed. Every other group shows more or less increase even in the last two years. The New England increase is small, but then the adjacent Middle group's increase is large, and the same explanation is applicable. The rapid and steady improvement in the three Southern groups is especially notable and gratifying. It is a new proof that no part of our great and united country will be left very far or very long behind the rest. May it always be so.

The Pacific group also has advanced very fast.

By studying the 1891 line of the first table just given it will be seen that five of the eight groups now compare very closely in mean train load, ranging only between 143.4 and 163.3 tons. The New England states show by far the smallest load, and are likely always to do so, because they have so little of the heavy through traffic to bring up the average. In the past ten years they have increased at about the same rate as the rest of the country and much faster than the adjacent Middle and North Central groups. It is likely that they are still somewhat below what they should be in proportion to other groups.

The Middle group is still much above the average, and is likely to be always, because of their enormous through trunk line traffic, but they have relatively fallen behind, for the very good reason that they have not had so much room for improvement, having led the van in improving the power and efficiency of locomotives. The Southwest group is also below the average owing to its light traffic and rapid construction of new railways (Kansas and Colorado are included in this group), but is likely to increase rapidly hereafter.

That the average haul and average rate per ton mile have a close relation to each other, and that short haul necessarily and reasonably means a some-

	So. Atl. 1882.	So. Atl. 1891.	So. C. 1882.	So. C. 1891.	S. W. 1882.	S. W. 1891.	Pac. 1882.	Pac. 1891.	U. S. 1882.	U. S. 1891.
Av. haul, miles	103	118	95	98	153	179	220	186	109	115
Rects. per ton, cts.	177	115	195	98.5	295	240	447	297	135	107
" per ton-mile	1.71	0.97	2.06	1.01	1.93	1.35	2.03	1.60	1.24	0.93
" per train-mile	$1.42	$1.52	$1.02	$1.50	$1.96	$1.70	$2.42	$2.39	$1.50	$1.53

Middle. 1882.	Middle. 1891.	No. Cent. 1882.	No. Cent. 1891.	N. W. 1882.	N. W. 1891.
80.7	80.4	127.3	134.8	208.2	205.6
89.7	70.1	110.8	109.0	402.9	217.6
1.04	0.78	1.03	0.81	1.93	1.07
$1.63	$1.57	$1.43	$1.32	$2.17	$1.72

what increased rate per ton mile, may be shown by the following little table, which we abstract from a very voluminous one, in part reproduced on another page:

The New England group charges but little more per ton hauled than the Middle, and far less than the North Central and Northwestern, but owing to its short haul (which has increased from 58 to 68 miles, however, in the last ten years) its rate per ton mile compares poorly, especially in amount of decrease in ten years. All the groups show a tendency to keep the receipts per train mile about the same. The change in the Northwest group is the most remarkable. There even the receipts per train mile have been reduced some 20%, and the rate per ton mile decreased nearly half to but little over that customary east of Chicago; a fact which tends to show that the old granger movement was not wholly without justification.

Constructing a similar abstract to the above for the Southern and Pacific groups, we have the figures given in the table below.

The Southern tendency has been to get considerably more per train mile, in spite of a very large decrease in average rate per ton mile, owing to the specially great improvement in average train load which we have already noted. The Southwest group is a slight exception to this rule. The Southern rates as a whole are now about as low as in other parts of the country with much heavier traffic. The process of assimilation to the conditions obtaining in the North has evidently been going on very rapidly.

The Pacific group are now the greatest exception to the general average. Though their haul is very long their mileage rate is very high both per ton mile and per train mile, while their average train load compares favorably with other groups. Of course expenses are somewhat higher west of the Rockies than east of them for almost every item. Still, as will be seen by Table 2 on another page, their ratio of expenses to earnings is not excessive nor their traffic especially thin, and it looks as if there were still room for some improvement in the railway rates and service on the Pacific coast.

One of the most interesting tables of all is an entirely new one, giving independent operating statistics for some 30 different great systems (really only 23 systems if informal unions by common ownership are counted) for 1870, 1880 and 1890. The growth shown is something stupendous both in mileage and (still more) capital and traffic handled. Some of the more interesting of these statistics are given in Table 3 on another page. They deserve fuller and more careful study than we can give them in this issue, as they are really quite unique, involving no little labor in compilation and telling in concise form some facts which it is well to know. We can, therefore, better make them the subject of a separate article in a following issue.

LETTERS TO THE EDITOR.

ASSISTING LOCOMOTIVES ON HEAVY GRADE.

Sir: In your paper of June 30, page 665, you speak of "a method of enabling a locomotive to haul trains up steep grades," in which the necessary power is got by, taking a double turn of a stationary cable around a grooved drum keyed on the driving axle, etc. Can you, or any of your readers, tell (or guess) how the drift of the cable toward one side as the drum revolves is provided for in the arrangement?

Anxious Inquirer.

Washington, D. C., July 13, 1892.

(We have no details of the working of the arrangement referred to, and shall be glad to have particulars from any of our readers.—Ed.)

CONTRACT PRICES AND PRICES FOR LABOR AND MATERIAL.

Sir: Please allow me to suggest that in publishing bids for work in various parts of the country, it would be well to to state in connection therewith prices for material and schedule of wages paid in the localities where the work is to be done. This information is necessary for the engineer desiring to derive any benefit from these published notices.

Very respectfully, M. S. Parker.

Great Falls, Mont., July 19, 1892.

(While the additional information referred to is certainly of importance, it is rarely obtainable, and it is not correct to say that without it engineers cannot derive "any benefit" from the published prices. We shall be very glad, however, if any of our correspondents who send us lists of prices bid on contract work, will give such pertinent notes as they can as to prices of labor and material in their locality.—Ed.)

THE MEANING OF THE WORD "TAP."

Your letter of the 15th came to hand. Referring to above sketch, I would like to inquire again as to the meaning of the term "tap," as I do not yet understand its significance.

Perhaps it would be of advantage to many of the German readers of Engineering News if you would publish the explanation of above subject in your paper.

Otto Iben.

Hamburg, Germany, March 3, 1892.

(The sketch referred to shows a section through a house with several plumbing fixtures in place and the house service connecting with the water main in the street. In such a case there is but one tap and that is at the point where the street main is "tapped" for the insertion of the service pipe leading to the house. Mr. Iben refers to the use of the word tap in the Manual of American Water-Works. In that book tap is always used in the sense stated, and never to denote a fixture within a house from which water is drawn.—Ed.)

THE GRANULATION OF IRON ORE.

Sir: In your issue of July 14 appears an article by Mr. Alex Sahlin, M. E., under the heading of "The Granulation of Iron Ores by Means of Crushers and Rolls," in which he gives the comparative power of a crusher and roll plant as 124 HP., with that of a Sturtevant mill plant as 201 HP.

Mr. Sahlin states: "In this estimate of power, the figures quoted by the manufacturers of each machine have been accepted." We desire to say that we do not know where Mr. Sahlin obtained his figures so far as the Sturtevant mill plant is concerned, and that he certainly did not obtain them from us, and we deny ever accepting such figures, which are wholly incorrect and misleading. The horse power consumed by the Sturtevant mill as indicated by Mr. Geo. H. Barrus, engineer, is 56.2 HP. for a 20-in. Sturtevant mill, including elevator, two screens, and conveyor. The above indicated power was taken while running on magnetic iron ore and grinding over 20 tons per hour from about 4-in. cubes to pass an 8 mesh screen.

Sturtevant Mill Co.,
E. C. Huxley, Pres.

Boston, July 25, 1892.

THE IRISH CANAL AND TUNNEL PROJECT.

Sir: As an English engineer and late English journalist, permit me to make a few remarks on your leader concerning Sir. Edward Watkin's latest wild idea. This scheme of his is of course absurd, and no one in England will take it seriously. Sir Edward is not so great a man as is supposed over here. His Southeastern Railway is wretchedly managed; the rolling stock, locomotives, depots, permanent way, etc., are miserable affairs, and the dividends paid are precarious. The Manchester, Sheffield & Lincolnshire Ry. is a shade better, but is notable for its broken axles; its dividend is precarious also. The Metropolitan Ry. pays a 4% dividend, but it serves a very populous district. Any American who has inspected the trains and the tunnel will be struck by its being the worst place for travel in the country. Then his scheme for bringing the M. S. & L. Ry. into London is ridiculous, as the line is not required, and it will never be able to compete with the Midland, Northwestern and Great Northern. Then you speak of his capital location for the channel tunnel. Unfortunately for him, he did not design it and locate it; the honor of this wonderful piece of work is due entirely to the Manchester geologist, Prof. Boyd Dawkins. Sir Edward Watkin is not considered an authority in the House of Commons on railway management, engineering or anything else, and his proposition about Ireland will be treated with silent contempt. I do not think that he is a particularly wealthy man. He was originally a stock jobber in connection with railway work and gradually worked up. He bears the same sort of reputation as Jay Gould, though he is not so cute nor so rich.

As you say, such schemes are of no use as settlers for Irish questions, and a ship canal across Ireland would be totally useless commercially. I do not see that a tunnel would be of any use from Scotland to Ireland either.

Permit me also to say a word about Home Rule. There is a minority of one-fifth in Ireland, loyal. They represent the industrious, honest people, and the great industries of Ireland, viz., shipbuilding and linen at Belfast are all in the hands of loyalists. The business of the country is in the hands of loyalists, and when home rule is talked of, the values of the stocks and shares in the financial concerns, banks, railways, etc., go down immediately. Giving the government to the Home Rulers would be like delivering New York Government into the hands of Tammany Hall. It would be difficult to deliver New York from the grip of a murderous, rumselling crew, and it seems a pity to let Ireland get into similar hands. Yours very truly, W.

New York, July 25, 1892.

(We did not assert nor imply that Sir Edward Watkin had "located" the channel tunnel; but only that he had been its leading promoter. The chairman of three great English railways is necessarily either a man of large wealth or of wide influence or both, and the respectful consideration given to his proposals by the London "Times" tends to show that our correspondent rather underrates the attention which his suggestions are likely to receive. We fully agree with our correspondent that they deserve no respect, but that is not the question. As for the Irish question generally, this is not the place to discuss it; but is our correspondent unaware that Tammany Hall now controls New York, by due process of law, and that no one dreams of dispossessing it by taking away the right of self-government from the city, but only by winning over a majority of the voters? Moreover, the city still manages to get along somehow and prosper moderately.—Ed.)

PACIFIC COAST ENGINEERING NOTES.

Sir: Since the fall of the Victor wire bridge at Victor, Cal., in 1890 (see Eng. News, Nov. 8, 1890), no further specimens of such bridge designing have been heard of in this section. One of the men engaged in building them has gone to Mexico and, from two models on exhibition in the Chamber of Commerce in Los Angeles, there are two more men here who should follow him. The sketch (Fig. 1) shows a structure but little behind the "wire suspension." All the heavy lines are of gas pipe connected by tees and crosses, the heavy diagonals are also gas pipe, but flattened out at ends to make connection, while the light diagonals are of wire rope woven up and down between the outer chords, resting upon saddles at the panel points and tightened by the turnbuckles as shown; so it is easy to see how an even tension can be obtained in the adjoining panels. The general make-up recommends this design as an out and out curiosity.

The one in Fig. 2 is "Frederick's Self Anchoring Suspension Bridge," and will need but little explanation, the heavy lines being timber and the light lines being

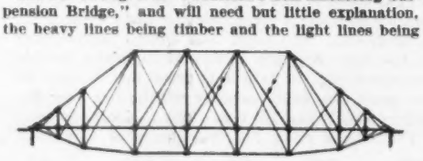


Fig. 1.

wire rope; the builder says the bridge made of 1¼, 1 and ¾-in. wire ropes will sustain a load of 150,000 lbs.; evidently being of the same mind as a Howe truss builder in the East, who kept chords ready packed in his yard, and when a 50-ft. span was sold sawed off enough; later for a 200-ft. span it was rolled along and more sawed off.

Whether his bridge that will sustain this load is of 50 or 200 ft. span, this man does not state in giving his sizes of cables. Just how either of these would act under loads will be left for a problem.

Some specimens of bridge work in an adjoining county, for which the city engineer of the town is responsible, show nearly as much talent. The King post truss has its bearings nearly half way along the chords toward the beam, and the heel or footing in Fig. 4 has only a half inch plate with two bolts and the timbers not notched.

These will suffice to illustrate a class of work which

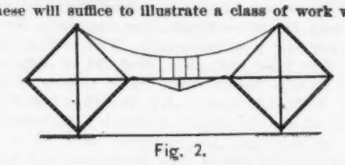


Fig. 2.

is only too common here, but it is to be hoped he will take warning and cease to figure as an expert. The inventors (?) of the two bridges named are offering to build them at cost, but it is to be hoped a timely warning will prevent any county from trying the experiment.

The principal activity here in railroad work has been the building of several branches to the beaches and in providing terminal facilities for the excursion business and ocean freights. The Sante Fe has built 5.4 miles from a point on the Ballona Branch to Santa Monica, and is now running about five trains daily to divide the traffic with the Southern Pacific, who have built an extension of 2.3 miles up the beach, which, it is rumored, is to extend to Santa Barbara. It is from the end of this 2.3 miles that it is proposed to build 6,000 ft. of pier and breakwater, to inclose about a square mile of harbor, the line of the pier curving around toward the north shore.

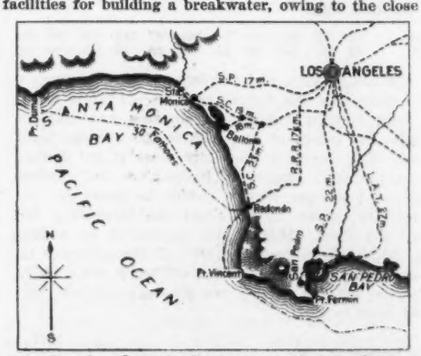
This and San Pedro are the sites on which the $200,000 appropriation of Congress is to be expended in sur-

Fig. 3.

Fig. 4.

veys, to determine the best point for a harbor for a port of entry for Los Angeles. At San Pedro there has been expended since 1870 the sum of $904,000, and there is yet to be expended the last appropriation of $51,000 in completing the inner harbor, which has now 14 ft. of water over the bar at low tide, where formerly there was but 18 ins., this having been accomplished by building about 10,000 lin. ft. of jetty, thus confining the ebb tide and removing at least 90% of the 2,000,000 cu. yds. of material estimated to have been removed; the other 10% being dredged. This has been the real port of Los Angeles and last year a new road, the Los Angeles Terminal—a road supposed to have been built as a terminus for the Union Pacific—was completed to East San Pedro, a length of 27 miles, and is now completing a wharf on the inner harbor.

Other franchises for wharf property have been obtained, in view of a plan for a deep water harbor, which has been reported by the U. S. Engineers, proposing to build a breakwater inside of Pt. Fermin. The survey has been ordered in accordance with a letter emanating from the Southern Pacific Ry., in which they claim advantages for Santa Monica in better protection from storms, better holding ground for anchorage and better facilities for building a breakwater, owing to the close



Map Showing Seaport Connections of Los Angeles, Cal.

proximity of good granite quarries. The relative advantages will no doubt be settled by the survey. The other seaport and only place where vessels land, except San Pedro, is Redondo; it being an open roadstead as is San Monica, but having a submarine bay, as shown by the 30 fathom curve, thus giving 51 ft. of

water off the end of about 700 ft. of wharf. This has recently had an extension of 100 ft., requiring piling upward of 110 ft. in length, and it was not possible to handle more than seven a day with one driver. The distances from the city by the various lines of railway are shown on the accompanying map—to which must be added for the S. P. Santa Monica line, the beach and wharf extension, making over 20 miles; for the Redondo Ry. must be added 2½ miles haul to the center of the city, making 20 miles. Vessels from the north can of course make an earlier landing at Redondo and still earlier at Santa Monica on the completion of the wharf, which is as yet on paper.

The Terminal has recently leased another road—the San Gabriel Valley Rapid Transit—and changed it to a standard gage; this continual increase of mileage, and the report of the U. S. Surveyors working over their former surveys, makes it quite sure there will soon be another transcontinental line built in here.

Since the visit of Hon. Warner Miller to the coast some weeks ago, people begin to see that the multiplication of railways cannot cheapen freights to any great extent, and hence there is an increased interest on all hands for the rapid completion of the Nicaragua Canal.

Work is still in progress on Prof. Lowe's line up Wilson's Peak, which it is proposed to build in three sections; the first starts from the end of an extension of the Altadena Branch of the L. A. Terminal and will be a double track cable, with balanced cars and safety racks, and operated with water power; there will be but few trestles on this section and these will be insignificant. It is said that from the end of this heavy grade section the grades will be comparatively light and the second section to the summit and the third along the range will be operated by electricity, using water power to run the dynamos. But like so many California schemes, this is still in embryo and will be much modified no doubt, if completed. It would reach an elevation of about 6,000 ft. and on account of the mild climate of eight months of the year, it would be very popular with tourists.

Besides the proposal to generate electricity by water power for this, there are two companies that propose, and are putting in plants, to furnish electricity for lights and power—one at Pomona and one at San Bernardino—and while Los Angeles people sit with closed eyes to the tens of thousands horse power going to waste in the mountain streams, complaining of paying ten and eleven dollars per ton for British Columbia and Australian coal, the towns mentioned will have made great strides toward gaining such manufactures as can adapt themselves to the country. C. E. Fowler.

Los Angeles, Cal., July 4, 1892.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XV.

THE ENGINEERING SCHOOLS OF CORNELL UNIVERSITY.

The circumstances connected with the foundation of Cornell University, by which it was enabled to secure its magnificent endowment fund, have been already detailed in reviewing the history of the Agricultural College Land Grant of 1862. In a word, Mr. Ezra Cornell paid $25,000 for the privilege of giving $500,000 more to found the university, and then managed its land grant with such splendid skill as to secure some $6,000,000 more for it than it would otherwise have received.

Two separate engineering schools, one for civil and one for mechanical engineering, were organized very early in the history of the university, which has tended from the first to make prominent instruction in the practical modern arts and sciences—to the neglect of the time-honored classical studies, its enemies have sometimes claimed; by relegating them to their proper relative position, its management and friends declare, and with far more truth and force. Certainly the expressed aim of the founder was broad enough: "I would found an institution where any person can find instruction in any study," and this the university has adopted as its motto. So broad a purpose cannot be achieved at once by any amount of effort or expenditure. That it will be achieved in time with some degree of completeness there is every reason to believe, as the university has conspicuously tended to expand in all directions, and has had most unusual success in attracting large gifts from many sources. An old college naturally tends to receive a good many gifts and bequests, because it has such a large body of alumni, but that an institution whose foundation was so recent and so largely the work of one man should find benefactor after benefactor ready to give it more money by hundreds of thousands in order to expand its work, when it was but just started by gifts from one man aggregating nearly $7,000,000, is a very remarkable fact, and highly creditable to its management.

To show more clearly how rapidly Cornell's resources have expanded as need arose, which is such an earnest of still future growth, we abstract and condense from the last report of President Chas. Kendall Adams the following table showing the increase in the productive funds and material equipment of the university in the seven years between Aug. 1, 1885, and Aug. 1, 1892:

Increase of income-bearing funds:	
Sales of land and timber (partly est.)	$1,220,580
Susan Linn Sage fund, for school of philosophy	250,000
Sage library endowment fund	300,000
Fayerweather fund	200,000
Four other small funds	6,532
Total increase of income funds	$1,986,112
Increase in buildings and equipment:	
From A. S. Barnes for Barnes Hall	45,000
" H. W. Sage for library building	260,000
" H. W. Sage, two other gifts	19,216
" President White, library	100,000
" Hiram Sibley, for mech. laboratory	16,000
" other persons for apparatus, etc.	25,000
Total increase in buildings and equipment	$465,216
Additions from current income:	
Sundry buildings	$384,081
Library, museum and laboratories	205,217
Sewerage, water-works, and vaults	69,664
Surplus fund (partly estd.)	47,747
Total increase from current income	706,706
Total from sales of land endowment	1,220,580
Total from further gifts	1,221,748
Grand total of 7 years' gain of funds	$3,158,037

This is a splendid record, and a remarkable and unprecedented one in this, that a university which was gaining funds much faster than it needed for current expenses from its own property and funds should attract so many and such large further gifts. Of course, the university has really had no surplus; far from it, because it was all the time building for the future; but except for this continuous effort to expand the scope of the university it would have had ample funds of its own without further gifts.

It is also a notable fact that, rapid as has been the growth of its engineering schools, and especially in mechanical engineering, the growth in its classical and literary developments has been still greater proportionately. The following Table XI. shows the number of graduates in each of the main departments of the university in each of the first 13 classes graduated. It will be seen that the College of Civil Engineering was effectively organized only two years later than the classical course, and Sibley College (of mechanical engineering) only four years later. For nine years thereafter the technical and scientific graduates were from three to five times as numerous as the non-scientific, and even in the last year of the table (1881) they were twice as numerous, while the three old "learned professions," as they are still sometimes called to the exclusion of all others, were not represented at all. It is notable also in Table XI. that the graduates in "science" were very much more numerous than those from all the technical courses put together.

Passing over the record for the four years 1882-5 as not particularly important for our purpose, Table XII. shows the corresponding record for the last seven years, which are practically coincident with the term of President Adams, who retires this year, and of Director Robert H. Thurston, Director of Sibley College.

Table XII.—Number of Graduates in each of the Several Departments of Cornell University, in Each of the Last Seven Classes Graduated.

Engineering courses.	1886	1887	1888	1889	1890	1891	1892
Civil engineering	10	17	21	14	15	24	32
Mech., regular	5	12	14	13	26	24	44
" electrical	5	7	8	19	28	28	46
" total	10	19	22	32	54	52	90
Architecture	6	4	11	6	10	8	6
Agriculture	1	..	7	6	7	11	8
Total, technical	27	40	61	58	95	93	136
Science	2	8	9	13	18	16	24
Chem. and pharmacy	..	1	2	2	4	3	..
Nat. history	4	..	..	..	..	..	..
Total, scientific	33	49	72	73	117	114	160
Law	..	..	9	36	32	44	41
Literature, letters	1	17	27	10	39	31	33
Arts and philos.	48	35	29	20	33	40	61
Total, non-scientific	49	52	65	84	104	115	135
Grand total	82	91	137	157	221	229	295
Post-grad. degrees.							
Scientific	7	3	6	7	14	12	20
Non-scientific	4	1	6	2	10	9	18

drafting room and not from schools. This seems the more curious because all the artistic side of architecture, which is its chief side as a separate profession, is capable of being taught perfectly in schools, whereas its practical side, in which it is merely a branch of engineering, cannot be so taught. And yet engineering is rapidly becoming a profession in which only the genius or college-bred man has much chance of success, whereas there seems to be no such demand for highly trained architects as to support even a single large and successful school of architecture. The reason for this strange contrast we will not stop to speculate upon, but the contrast is certainly creditable to the engineering profession, if not discreditable to the architectural.

The civil engineering college, of which Prof. E. A. Fuertes is director, will be seen to have tripled its number of graduates in seven years, which is certainly rapid enough growth for any engineering school, in addition to which a large fraction of the instruction of the mechanical and electrical engineer is given in the civil engineering college. When this fact also is borne in mind, its growth has had few parallels among civil engineering schools, and is perhaps as rapid as is ordinarily desirable or healthful. Only by comparison with the growth in the mechanical department does its growth appear slow.

But the growth in this latter department has been something phenomenal, as a record of seven years' growth. In part this has resulted necessarily from a general tendency of the times to which our next article will bear interesting evidence. Whereas a few years ago a practicing mechanical engineer was a rarity, to-day mechanical engineering is passing civil engineering by leaps and bounds, and bids fair soon to entirely overshadow it as a department of engineering practice. The new profession of electrical engineering alone bids fair to overshadow both civil and (other forms of) mechanical engineering before long, but even apart from that new department of mechanical engineering, the relative importance of so-called "civil" engineering, or the construction of fixed public and private works, is steadily growing less in comparison with the vast and ever-growing demand for dynamic and mechanical engineering work. To this last there is no natural limit; to the construction of railways and water-

Table XI.—Number of Graduates in Each of the Several Departments of Cornell University in Each of the First Thirteen Classes Graduated.

	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.
Civil Engineering	..	..	7	16	18	15	8	12	15	14	10	7	9
Mech.	..	..	..	..	3	1	5	6	7	12	5	3	3
Architecture	..	..	..	..	1	6	4	6	4	2	6	2	..
Agriculture	..	..	..	..	2	2	1	1	2	1	..	3	8
Total Technical	..	..	7	16	24	24	18	25	31	29	20	15	20
Science	..	8	16	38	45	30	21	26	24	24	33	40	35
Total scientific	..	8	23	54	69	54	39	51	55	53	53	55	55
Letters	8	8	7	4	20	8	8	9	7	12	14	17	23
Philosophy	..	7	9	9	6	3	5	3	8	2	..	4	4
Total non-scientific	8	15	16	13	26	11	13	12	15	14	14	21	27
Grand total	8	23	39	67	95	65	52	63	70	67	67	76	82
Post-graduate degrees:													
Scientific	..	..	..	1	1	7	3	6	5	2	3	..	3
Non-scientific	..	..	..	1	2	1	..	4	3	1	1	..	..

(Two graduates in veterinary medicine, in 1871 and 1872, are omitted from this table.)

It will be seen that both the engineering departments show very rapid growth, in marked contrast with the architectural and agricultural departments, which are about the same as they were fifteen years ago. We pause a moment to note the curious fact that no schools of architecture have succeeded as yet in achieving any marked and permanent success, nor is there yet any visible tendency to educate all architects in colleges as there is to educate all engineers. The practicing architect still graduates from the

works there is. This same cause has made the English "Institution of Civil Engineers" chiefly an association of mechanical engineers. The same thing must inevitably happen the American Society of Civil Engineers, unless, as seems to be the present tendency, the mechanical and electrical engineers decline to recognize the term "civil" as broadly inclusive of all non-military engineers, and ignore the "civil" society altogether. In the latter case, the relative importance of the civil society must continue to decline, just as has the relative number of civil engineering graduates.

But after all allowances are made for this natural cause, the recent rapid growth of the mechanical engineering department remains a notable phenomenon. Its causes would be of extreme interest if we could hope to record them accurately. That we cannot do, but we can at least note some of the attendant circumstances that seem to have a bearing on its success.

Soon after the establishment of the university Mr. Hiram Sibley, of Rochester, one of Mr. Cornell's colleagues in the legislature, founded and partially equipped the "Sibley College of Mechanical Engineering and the Mechanic Arts" by erecting its first building at a cost of $30,000, and adding further gifts of money which up to the time of his death in 1888 had aggregated about $125,000. He left by his will $200,000 more to the institution.

The new college went along in a useful but not particularly brilliant career, as already noted, until the spring of 1885. About that time the brilliant success of Stevens (we may well believe), which had been founded contemporaneously with Sibley College, and had certainly had to contend against narrower means, but which was then graduating classes of 36 to 40 against 5 to 10 only at Sibley College (as we shall see in the next following article), awakened the trustees, and especially President Andrew D. White, who was then the ruling spirit of the university, to the fact that Sibley College needed to have new life put into it, and the trustees resolved on reorganization and expansion. As the first step thereto they summoned for council a number of engineers and possible professors, in order to obtain their advice, and doubtless also to look them over in respect to their qualifications for the position of director of the reorganized college. Among the men thus summoned were Prof. Robert H. Thurston and Mr. Wm. Kent, of Stevens; Mr. Charles E. Emery, of New York; Prof. Chas. B. Richards, of Yale, and possibly others. Shortly thereafter Prof. Thurston was tendered and accepted the appointment of director, in which he still remains. In this selection the trustees acted with obvious shrewdness, since "nothing succeeds like success," and Prof. Thurston could unquestionably claim that, whether by his own merit or not, he had the most successful record of any man in the country as a professor of mechanical engineering up to that time. As his record since, under fuller responsibilities, has also been remarkably successful, it is but reasonable to attribute a large part of the success of both colleges to Prof. Thurston's personal efforts and abilities. It may have been mere luck in both cases—a combination of favoring circumstances; but we are no great believers in "luck" in such matters. Napoleon had the wiser rule, to always trust the "lucky" men, and always distrust and drop the "unlucky" ones. Nine times out of ten the general, or the college, which adopts that policy will win, and the one which neglects it will lose.

Cornell has won, at any rate, and yet, on looking through the mass of documentary records before us we fail to detect any special peculiarities in its methods to explain why it should have won, other than general good management. It has had comparatively abundant means, for one thing, and without them could not possibly have grown so fast, but in this age of large bequests it is only necessary to use one dollar well to have other dollars added to it before long, and Cornell's resources have come from so many different sources that this abundance of means should be looked upon as an effect, rather than a cause of its successful management.

What was done, however, when and after Sibley College was reorganized in 1885 was, in the first place, to put the entire responsibility for its management upon a single head, to a very unusual extent. The director was given power to nominate all assistants, to regulate the expenditure of the funds, to assign their duties to all the professors and instructors of the college at his discretion, and in general to exercise plenary executive authority without any supervision whatsoever, except that all his acts "affected by or affecting the general body and controlling regulations of the university" were made subject to the approval of the president and trustees. In the words of the original instructions: "The director will be held responsible for results, and will be allowed to take such course, in the organization and administration of the internal affairs of the college, as may seem to him best calculated to secure the results aimed at by the authorities from whom he receives his powers." The trustees also promised all moral and material support up to the limit of the university's resources, and made it a leading duty of the director to make suggestions for further expansions of the college work as fast as opportunities permitted, in order to secure "the most perfect practicable organization" and "the highest possible efficiency."

These were unusual powers, such as small men hate to grant. They tended to concentrate responsibility and unify the management of the college. They were one of the causes of its success. It was the opportunity which these powers offered, rather than any pecuniary inducement, which led Prof. Thurston to make the change, which he declares in his first report that he made "at some sacrifice of apparent personal interests," adding with truth: "An opportunity to take part in the organization and development of a great school of engineering so rarely offers, and is of so exceptional and important a nature, that few thinking men would decline it, if offered, if competent to take any part in the work."

These exceptional powers were not stated to be permanent originally, and perhaps not intended to be. They continued for five years, to June, 1890, when the director reported to the Board of Trustees that he considered his work as practically accomplished, so far as the means at his disposal permitted, and tendered them the authority which had been temporarily conferred upon him. He had organized the undergraduate department, and had seen a school of almost as great magnitude as was the university at his appointment take form during the five years. But the trustees declined to relieve him of those responsibilities; formally declared their satisfaction with the then existing arrangement; proposed that it should be continued, gave him $50,000 to complete his preparations for the foundation of graduate schools; authorized the immediate organization of the school of marine engineering; the completion of the organization in electrical engineering and in the department of experimental engineering, and, without solicitation on his part, added a thousand dollars to his salary. This was two years ago. The college has now ten times as many students as in 1885-86, and correspondingly enlarged plant and facilities. But it is at the end of its rope in some ways. It is crowded with students, and is earnestly demanding "three hundred thousand more" for present needs and to provide for another prospective five years of growth; though the gains can hardly be expected to be as rapid as hitherto, as the college ought to have pretty nearly reached the limits of its drainage area. Cornell, as we shall see, has low tuition fees and a very large number of free students under the law of the state, so that its receipts from fees are less of a resource than at many colleges.

The great extensions of the powers of the director which were granted to Sibley College extend also to the College of Civil Engineering, which is an entirely separate and independent organization, of which Prof. E. A. Fuertes is director. Instead of being mere university departments, absolutely subject to the general faculty, both of these colleges enjoy a nominally almost perfect independence analogous to those enjoyed by the law and medical schools of most universities. Really, we infer, past tendencies and traditions interfere to prevent as great actual as legal independence, but the tendency is to make them more independent all the time. As the general faculty has always been disposed to dignify the scientific courses by treating them of at least equal importance with the classical, however, this large measure of independence has not been so important as it would be at many other universities where the tendency of the governing body is distinctly non-scientific.

Prof. Thurston laid great stress in his proposals for reorganization on the necessity of thorough workshop and laboratory instruction. In this policy he was one of the leaders, and he has consistently followed it ever since, placing his college at least abreast of any other in the country in that respect, we judge, though comparisons are odious as well as difficult, and we endeavor to avoid them. There are a goodly number of colleges between which there is not much to choose in this respect; but Cornell's vigorous policy in regard to it has been one of the causes of its success.

In one respect Prof. Thurston's original program has not been followed to any extent, and perhaps fortunately, viz., the establishment of "schools for superintendents" or manual training schools of a high grade, as an adjunct and accompaniment to the shop training of the regular engineering students. A strong and plausible argument in favor of this combination is that the same plant and staff can be used for both purposes to a large extent; but the difficulty is that the class of students and the kind of instruction needed are quite different. Certain it is that this feature of his original scheme has not yet come to much. A plausible reason for this is assigned, that there has not been room even for the regular engineering students, but we think a stronger one is that such unequal yoking together of dissimilar things is not expedient.

Prof. Thurston's policy has also been to assimilate engineering colleges to other professional schools by assuming that the student has had a thorough general education before the college is entered, and so making its course purely professional. We have some doubts of the wisdom of this policy, and of the soundness of the analogy with medical, law and divinity schools by which it is defended. For these latter the ordinary college course has always been regarded as highly desirable preparation, and it is generally taken. We should certainly advise every young man to take the same course before entering an engineering school if he can do so, agreeing to that extent with Prof. Thurston. But as educational systems are now organized, the tendency must always be for young men to enter the engineering school as a substitute to entering the ordinary collegiate course, and not as a preliminary thereto. He will therefore have a poor general education for a professional man, even if he comes to the engineering school as well prepared as he has to be to enter the old-fashioned collegiate course, which he rarely does, as we shall see when we reach the subject of requirements for admission. Therefore, to justify this policy of making the engineering course purely technical, the requirements for admission should be made at least as high as to enter the ordinary junior class at college, instead of lower than to enter the ordinary freshman class. We suggest these doubts with much hesitation, as we cannot pretend to have studied the question with the care of professional educators; but the outside observer sometimes gets a better perspective, and at any rate must have his opinion.

Be this as it may, however, Prof. Thurston undoubtedly took a wise step in pushing out of his course a full year of elementary mathematical and high school work, and demanding this of the candidate for admission, using the time thus saved for expansion at the other end of the course of instruction. By pushing this policy a little further there could be no objection to confining the engineering course to purely technical studies.

Among the desirable reforms introduced in 1885 the first two years' course in all the engineering departments was made substantially identical, so that segregration began only with the third year, while segregation of the mechanical and electrical aspirants was postponed until the fourth year. These changes were also so made as to enable the graduate from any "regular" college course to enter the junior year, as a rule.

The college is organized in three main departments, which for the most part are independent of each other, viz., the department of drawing, the department of practical mechanics and the department of mechanical engineering in the restricted sense, i. e., the studies dealing with abstract principles and their application. Three post-graduate schools for a one-year's course in marine engineering, steam engineering and railway machinery were announced in 1885, but they did not materialize until 1890, when a graduate course in marine engineering was firmly established, which promises to be very successful. That in railway machinery has been similarly established this year. One on the engineering

of textile manufactures is contemplated. A year or more of post-graduate study in electrical engineering, however, as also in civil and mechanical engineering, was early provided for and is taken yearly by a few.

In our next issue we shall proceed to summarize the historical facts in regard to the total number of graduates in engineering in each year since there began to be any such graduate in the United States.

METAL TIES FOR RAILWAYS.

The daily press has recently contained statements to the effect that the Pennsylvania R. R. has abandoned its experiments with metal ties, having found such ties unsatisfactory, and conclusions have been drawn unfavorable to the use of metal ties. As a matter of fact the Pennsylvania R. R. has made but limited experiments, including a tie designed by officers of the road and built up of a channel iron with riveted brackets, and the Webb rolled steel tie with riveted chairs for bull-headed rails, as used on the London & Northwestern Ry., England. The ties of the former type were too weak for the service, and were removed from the main track to a roundhouse switch track at Philadelphia, where we saw them less than a year ago, bent all out of shape. The English ties, carrying the English bull-head rails, were found difficult to keep in line. On the other hand, the New York Central R. R. and the Chicago & Western Indiana R. R. have had good results with steel ties, as noted in our issues of March 12 and April 2, 1892, and Feb. 7, 1891, and metal ties have been found very successful in other countries. We reprint below a letter written to the Washington "Post" by Mr. B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, pointing out the wrong impression that is being given by the statement above referred to in regard to the Pennsylvania R. R. The report mentioned by Mr. Fernow was made to the U. S. Government by Mr. E. E. Russell Tratman, Associate Editor of Engineering News, and was reviewed in our issues of Aug. 30, 1890, and Aug. 15, 1891. Mr. Fernow's letter is as follows:

In this morning's issue I observe a paragraph on the use of metal railway ties in this country, in which it is asserted that the Pennsylvania R. R. Co. has experimented with metal ties for 15 years and finds them unsatisfactory.

Since this matter is of more importance than it may at first appear, allow me to correct the impression which such a statement might produce in the minds of the public and uninformed railway engineers. Two years ago there was published from this Division a report of over 350 pages, giving in greatest detail the experiments, not of the United States alone, but of the entire world, with reference to the use of metal for railway ties. It is there shown by actual statistics that over 25,000 miles of railway track of the world is laid on metal, and this kind of track has proved itself in most cases absolutely satisfactory and successful. In comparison with experiments of such magnitude, under all sorts of conditions, the alleged small trials of the few ties in the tracks of the Pennsylvania R. R. Co. are of no value whatsoever. To show the folly of generalizing from these few trials, allow me to say that in the report above referred to there are described 491 patents taken out in the United States alone, none of which is in actual use. There are, furthermore, described some 30 patents in actual use. It would, therefore, appear that the system or patent used in the trials referred to would have to be stated in order to found an opinion, not on the efficiency of metal track, but on the efficiency of that patent.

In conclusion allow me to quote the resulting judgment from the reports of the chief engineers in control of nearly 25,000 miles of metal track, which I have worded as follows: "It is not a consideration of initial cost that makes the substitution of metal ties desirable or profitable. It is superiority of track, permanence of roadbed, safety, greatly reduced cost of maintenance, and hence ultimate saving and economy, that recommend the metal tie."

THE LARIMER STEEL COLUMN.

The growing increase in the adoption of steel construction for large buildings has given rise to much discussion on the merits of different forms of rolled steel and iron columns for this class of steel architectural work. In our two last volumes were published articles by Mr. C. T. Purdy, of Chicago, on "The Steel Skeleton Type of High Buildings" (Eng. News, Dec. 5, 12, 26, 1891, and Jan. 2, 1892), which gave rise to considerable discussion as to the advantages of different forms of columns (Eng. News, Jan. 9, Jan. 30, March 12 and May 5, 1892). In our issue of Dec. 12, 1891, we gave a cross-section of the Larimer column, and now present more detailed

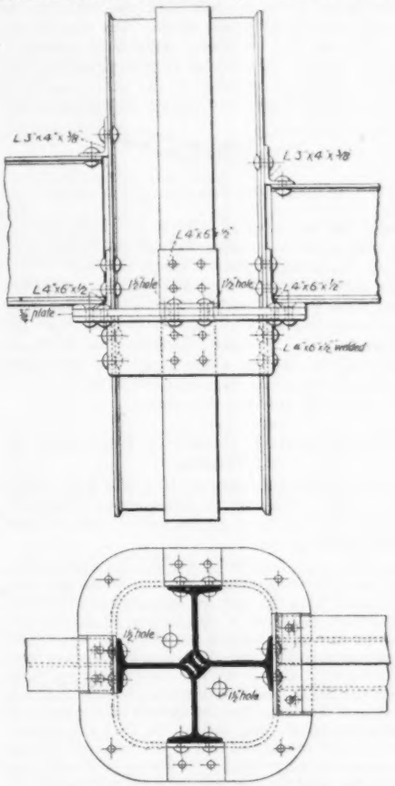
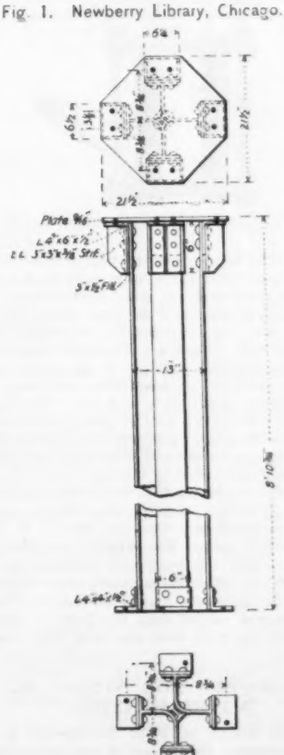


Fig. 1. Newberry Library, Chicago.



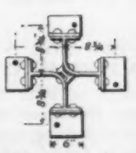


Fig. 2. Huck & Young Building, Chicago.

LARIMER COLUMNS AND CONNECTIONS.

drawings of this column, which was patented by Mr. J. M. Larimer, in 1891, and is manufactured by the Jones & Laughlin Co., of Chicago. It was put upon the market about a year ago, and 500 tons have already been sold.

This column is composed of two steel I-beams, each bent to a right angle at the middle of the web, and riveted to a small central I-beam by a single row of rivets passing through the webs of the three I-beams, as shown on the accompanying cuts, which represent the columns and connections used in the Newberry Library, Chicago, Fig. 1, and the Huck & Young Building, Chicago, Fig. 2. A perfect column should have not only the greatest strength to be obtained by distribution of the metal, but should be easily connected to girders and joists and occupy the least space consistent with the duty required, in order to be "fireproofed," and this column is claimed to combine all the good points of other forms of columns. The construction is simple; the beams bent to shape are united to the central beam by only one row of rivets, the proportion of the metal carrying the greatest load being on the peripheral flanges and the minimum of metal at or near the neutral axis. These columns, owing to this form of construction, can be reinforced to carry any load, and the floor or girder connections can be made at any height or from any direction. The Larimer column can be connected with perforated or notched plates to allow the use of wires, pipes, etc., which adds much to the desirability of this column. Tests made at the Watertown Arsenal are said to have demonstrated the good qualities of this form of construction.

The makers claim that with other forms of columns, not made on this principle, the defects are: 1, the space they take up is too great, and at present high prices of property the architects and owners are desirous of saving every available square inch of surface; 2, difficulty in connecting to them; 3, expense in manufacture; and, 4, the weakness developed by the extra amount of punching, drilling, riveting, etc.

PROPORTION OF COLORED POPULATION IN THE SOUTH.

Census Bulletin No. 197, giving the colored and foreign born population of the four southernmost Atlantic coast states, apparently indicates that even in these states, where the colored population might be expected to increase faster than the white, it is relatively diminishing. What the bulletin indicates even more strongly, however, is that for several decades the census of our colored population has been quite defective, and that the census of 1890 is probably no exception to this rule, and errs somewhat by omissions. Previous bulletins show that in all the more northerly Atlantic coast states the percentage of colored population has been decreasing quite decidedly. The following little table gives the facts as to the Southern Atlantic states:

Per cent. of Colored Population.

	No. Ca.	So. Ca.	Ga.	Fla.
1890	37.77	59.87	46.75	42.53
1880	38.04	60.72	44.03	44.08
1870	36.67	58.95	46.04	48.84
1860	36.54	58.60	44.05	44.65
1850	36.36	58.93	42.44	46.02

Per cent. of Increase.

	No. Ca.		So. Ca.		Ga.		Fla.	
	Wh.	Col.	Wh.	Col.	Wh.	Col.	Wh.	Col.
1890 ..	21.7	5.6	18.1	14.0	19.8	18.4	57.7	31.2
1880 ..	27.8	35.5	35.0	45.3	27.9	33.0	48.5	38.4
1870 ..	7.7	8.3	—.6	0.9	8.0	17.1	23.6	46.3
1860 ..	13.9	14.8	6.1	4.7	13.4	21.1	64.7	55.7
1850 ..	14.1	17.7	6.0	17.5	27.9	35.6	68.9	51.7

In per cent. of colored population there is a very sudden—a preternaturally sudden—falling off in 1890, but the irregularity in the percentages of increase shown in the second part of the table is calculated to raise grave doubts as to the genuineness of this apparent decrease. The census of 1870 is admitted to have erred seriously by omission. That of 1880 is supposed to have been very accurate, but necessarily it could not well err by excess. That the old slave states north of the Carolinas are not increasing in colored population is clear from the following table, even allowing for considerable errors of omission:

Per cent. of Colored Population.

	Del.	Md.	D. C.	Va.	W. Va.
1890	16.87	20.71	32.86	38.40	4.29
1880	18.04	22.49	33.56	41.76	4.15
1870	18.23	22.46	32.97	41.88	4.07
1860	19.27	24.91	19.07	34.39	....
1850	22.25	28.32	26.59	37.06	....

Per cent. of Increase.

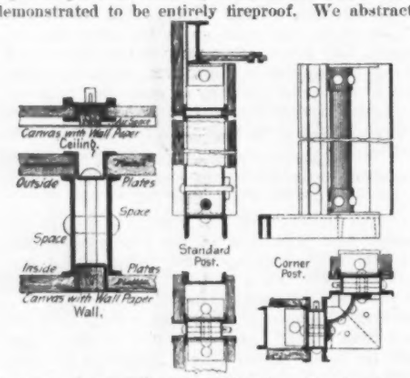
	Del.		Md.		D. C.		Va.	
	Wh.	Col.	Wh.	Col.	Wh.	Col.	Wh.	Col.
1890 ..	16.6	7.5	14.1	2.7	31.1	27.0	15.8	0.7
1880 ..	17.6	16.0	19.7	19.9	33.7	37.3	23.7	23.1
1870 ..	12.8	5.4	17.4	2.5	45.3	203.3	-32.0	-6.5
1860 ..	27.3	6.2	23.4	5.7	60.1	4.1	17.0	4.2
1850 ..	21.5	4.3	31.6	9.0	23.8	5.3	20.8	5.6

Perhaps it is a safe conclusion from all the facts so far published that the colored race as a whole tends to increase more slowly than the native whites alone, apart from the white gain from immigration, and that the race tends to concentrate itself in the more southerly states, so that only in those states, if even there, is there any likelihood of its maintaining its present relative importance. Florida has a very considerable foreign-born population, alone of the South Atlantic states, so that the decrease in colored percentage there is largely accounted for by this immigration.

Since the above was written the total colored population of the United States has been announced, as shown by a bulletin not yet issued, to be 7,400,040, including only persons of African descent, and omitting 107,475 Chinese, 2,039 Japanese and 58,806 civilized Indians. This is an increase of 889,247, or 13.51% in the last decade, against a nominal 34.85% in the previous decade. Even if there be considerable errors of omission in this part of the 1890 census this low percentage is all but certain evidence that the natural increase of the colored race is much less than of the white, so that the negro problem must become yearly less serious. It is notable also that the number of civilized Indians has decreased absolutely as well as relatively.

XYLOLITH, A NEW BUILDING MATERIAL.

This new material, xylolith (wood-stone), is, on account of its lightness and durability, rapidly coming into practical use, especially since it has been demonstrated to be entirely fireproof. We abstract



Methods of Using Xylolith in Building Construction.

the following description of the product and its use from the "Centralblatt der Bauverwaltung:"

The method of constructing walls and ceilings of xylolith and iron is shown in Fig. 1. The plates of xylolith are pressed by flanged channel irons against iron posts, and the horizontal joints or seams are closed by + irons, which serve in place of tongues and grooves. As the material is very light in weight, buildings can be constructed rapidly with this material even with unskilled workmen. The pulling down of such structures is also effected without much difficulty, and the materials can be used over again. Fig. 2 shows some details of construction for portable dwelling houses. As a covering for floors and stairs the material is considered unrivaled. As a proof of this it is stated that at the entrance of the waiting room in a railway station at Dresden the 1 1-32-in. board flooring had to be regularly renewed every year, while the 23-32-in. xylolith floor, with which it was finally replaced, has withstood the wear of 2¼ years already, and yet seems to be intact. As a conductor of heat xylolith stands between cork and asbestos. In its manufacture materials are employed which are antiseptic, so that a flooring of xylolith seems specially commendable for hospitals and similar structures. Xylolith is being manufactured by Otto Sening & Company, Potschappel, Germany.

WIRE GLASS.

"Wire glass," or glass in which a wire netting has been embedded while in a liquid or plastic state in a manner analogous to the Monier system for constructing long span concrete arches, as described in our issue of May 23, 1891, is being extensively used in Germany for skylights and similar purposes, according to the "Centralblatt der Bauverwaltung," which says:

The great resistance of wire-glass is caused by the fact that where the glass is subjected to bending under heavy loads, the imbedded wire takes up the greater part of the tensile strain. The manufacturers have not yet effectively utilized this principle, that is, to place the wire as near as possible to the side of the plate subjected to the greatest tension. Tests made with a plate of which the thickness was

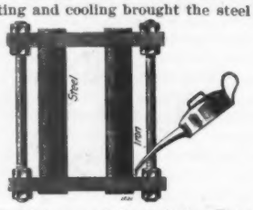
Sketch Showing Fracture of Wire Glass

divided by the layer of wire in the proportion of 1:3 gave a mean breaking strength of 4,366.8 lbs. per sq. in., while common glass of the same dimensions only showed 3,071.5 lbs. While conducting these tests it was found that even after the wire-glass plate had sustained a fracture, the wire imbedded held the two parts joint-like, as shown in engraving, so that the whole would still offer some resistance. Wire-glass is manufactured in the works of Fr. Siemens, Dresden, Germany.

TESTS OF BOILER TUBES OF IRON AND OF STEEL.

Some comparative tests of iron and steel boiler tubes, carried out by Mr. A. Blechynden, of Barrow, England, are described as follows in a recent issue of "Engineering:"

The first test consisted of heating and cooling two tubes, one of wrought iron and the other of steel. Both tubes were 2¾ ins. in diameter and 0.16 in. thickness of metal. At a temperature of 48° F., the length of both the steel and the iron tube was 55.495 ins. When heated to 186° the length of the steel tube was 55.547 ins., and of the iron tube 55.543 ins. The tubes were put in the same furnace, made red hot, and then dipped in water. The length was then gaged at a temperature of 46°, and that of the steel tubes were found to be 55.488 ins., and that of the iron tube 55.492 ins. Upon the process being repeated the steel tube was found to be 55.457 ins. long and the iron tube 55.4885 ins. A third heating and cooling brought the steel tube to a



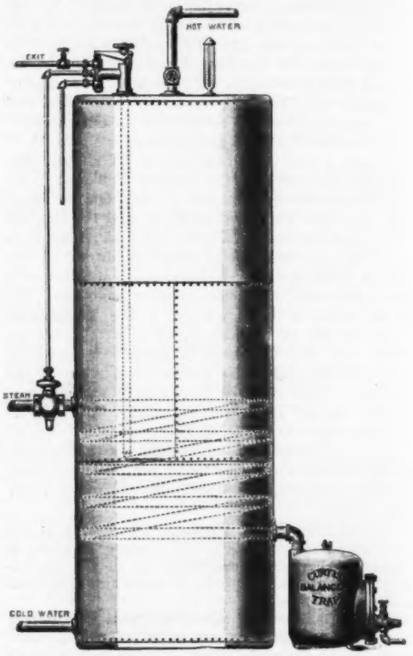
Test of Iron and Steel Boiler Tubes.

length of 55.44075 ins., and the iron tube to 55.482 ins.

The tests of both tubes were conducted simultaneously, and every care was taken to make them exactly alike. It will be seen that the total contraction of the steel tube, after the third cooling, was 0.05425 in., and of the iron tube 0.01300 in. The steel was Siemens-Martin (open-hearth), such as is generally used for tubes for Admiralty boilers. The iron was B. B. quality, Scotch make. The next test was made by putting two tubes into a pair of plates bolted together, as shown in the annexed sketch. Each hole was rimered with the same bit, and each tube end turned to the same gage and rolled by the same man. The diameter of the tube was 2¾ ins., each being of the same thickness. The steel was Siemens-Martin, made to Admiralty requirements. The iron was B. B. quality, ordinary Scotch make. The whole was heated in a furnace to a dull red heat, and dropped into water of about 100° F. After the structure was cooled it was found that the steel tube was so slack in the hole that when water was poured upon the joint, as shown, it ran between the plate and the tube. The iron tube was tight.

A THERMOSTAT FOR STEAM OR HOT WATER HEATING.

The usual method of using thermostats or automatic temperature regulators in connection with a steam or hot water heating system is to place one in every room to be heated and have it govern the flow of the heating fluid into the radiating pipes. When properly carried out almost perfect regulation is attainable by this system; but the expense of providing and maintaining a regulator for each room or each radiator is such that their use is quite limited. To meet the demand for a simple automatic system of temperature regulation of moderate cost the Curtis Regulator Co., of Boston, are offering a thermostat intended for attachment directly to the boiler or other source of heat supply, to regulate the flow of the heating fluid at its source. The device is of the differential expansion type, consisting of a ⅝-in. brass tube containing a steel rod. At one end the two are made fast, and at the other the motion due to the different rates of expansion is transmitted to a lever which multiplies it four-fold. This motion is utilized to open a small valve admitting fluid pressure from any convenient source to move the larger valves controlling the flow of steam or hot water. The manufacturers state that one degree change of temperature produces sufficient movement to open or close the valve.



Curtis Automatic Temperature Regulator Applied to a Boiler for Hot Water Heating.

The arrangement of the thermostat and valve is varied according to the nature of the plant. In low pressure steam-heating boilers the thermostat is put in the circulating pipe to the radiators. In hot-water heating boilers the thermostat may be put into the equalizing pipe between the top and bottom of the boiler, or directly into the boiler, whichever is most convenient. In dry rooms and greenhouses it is fastened to the wall vertically or extends horizontally into the room. A hand-wheel is provided by which the temperature at which the thermostat will move the valves can be adjusted very accurately.

The accompanying illustration shows one of these thermostats attached to a hot-water heating boiler supplied with steam from a street main. The metallic tube of the thermostat is suspended in the hot water. The steam valve is normally held open by a strong spring. Increase of temperature causes the thermostat to expand and let on street or other pressure to the top of the valve, forcing it to its seat.

The Chicago Drainage Board is letting contracts for the drainage canal which was described in our issue of June 2, and the bids for which were given in our issue of June 30. The Board having learned that the city authorities contemplate the erection of a new swing bridge over the river at South Halsted St., appointed a committee to confer with the Commissioner of Public Works and the City Engineer with a view to having a bridge constructed at this time which might be useful and serviceable after the river is widened in order to obtain the necessary flow of 300,000 cu. ft. of water through it. The Drainage Board has control of the river and it is its duty to exercise that control so as to prevent the construction of expensive bridges at this time, which may be rendered worthless by the widening of the stream a few years later.

RAILWAYS OF THE UNITED STATES IN 1891.

The advance sheets of the introduction to "Poor's Manual of the Railroads of the United States" for 1892, just issued, contain the usual very complete details of railway operation and construction in this country for the calendar year just passed. We have abstracted and rearranged the more important of these figures in the accompanying tables, and have also reviewed some of the especially interesting features of the report in our editorial columns.

According to the Manual the total extent of railway in this country on Dec. 31, 1891, was 170,601.18 miles, of which full statistics of operations were received from companies operating 164,262 miles. Of this 167,909 miles were completed before the close of the fiscal year of the several companies and 2,692 miles since that time. The capitalization of the 167,909 miles completed during the fiscal year was as follows:

Liabilities.	
Capital Stock	$4,809,176,051
Funded Debt	5,235,295,074
Unfunded Debt	345,362,506
Current Debt	375,791,813
Total Liabilities	$10,765,626,041
Assets.	
Cost Ry. and Equipment	$9,008,042,194
Real Estate, Stocks, Bonds and other Investments	1,617,031,080
Other Assets	239,159,462
Current Accounts	246,102,540
Total Assets	$11,110,335,276
Excess of Assets over Liabilities	$344,709,235
Excess of Assets of Various Railway Companies	$482,376,159
Excess of Liabilities of Various Railway Companies	137,666,924
	$344,709,235

The results of operations for 164,262 miles of railway were as follows:

Earnings.—Passengers	$290,799,696
Freight	754,185,910
Other	80,549,209
Elevated Railroads	12,489,644
Total Traffic Revenue	$1,138,024,459
Operating Expenses	781,796,576
Net Earnings	$356,227,883
Other Receipts, including rentals received by lessor companies	101,276,183
Total Available Revenue	$457,504,066
Payments from Available Revenue:	
Interest on Bonds	$225,339,413
Other Interest	5,920,397
Dividends	90,719,757
Rentals, Tolls, etc.	64,255,732
Miscellaneous	31,018,045
Total	$417,253,344
Balance—Excess of Available Revenue over Actual Payments therefrom for the year	$40,250,722

In Table 1 the capitalization and the various figures of operation per mile of railway are shown for each of the last seven years, 1885 to 1891, inclusive. It will be noticed that the earnings per passenger per mile show but little decrease for the seven years, but that on the other hand the freight earnings per ton per mile have decreased 10.3% since 1885. Both the dividend rate and rate of interest on bonds will be seen to be falling, having decreased 8.41% and 8.9% respectively since 1885. It will also be seen that while the capital stock per mile of road shows an almost constant decrease for the last seven years, the bonded debt shows a very heavy increase, 5.85%, a change which it is almost unnecessary to say is not gratifying from the point of view of good railway management. An increase is shown in the average haul and a decrease in the average passenger journey.

Further details of interest in this connection will be found in Table 4, which gives by groups the figures relating to the character of the track and equipment, and the general financial condition and results of operations of the several companies doing business. Probably the most interesting of the tables given are Tables 2 and 3. Both of these, as well as the other figures given, are fully discussed in another column.

The mileage of new track laid during the calendar year of 1891 is given by the Manual as 4,471 miles. These figures are 415 miles larger than those given in our issue of Jan. 23, 1892, which showed the new railway construction of 1891 to be 4,056 miles. Further and more correct returns received since that date have changed this total but slightly, and their general tendency has been to decrease rather than increase the total as given at that early date. As the Manual publishes no detailed list of the new track laid, it is impossible to tell where the discrep-

Table 3.—Showing Comparative Mileage of Railway Line, Freight Ton Mileage, Rate per Passenger per Mile, and Rate per Freight Ton Mile of Leading Railways in Various Sections of the Country for 1870, 1880 and 1890.

	1870				1880				1890			
	Miles railway owned.	Freight movement. ton miles.	Av. rate per ton pass. mile.	Av. rate per ton mile.	Miles railway owned.	Freight movement. ton miles.	Av. rate per ton pass. mile.	Av. rate per ton mile.	Miles railway owned.	Freight movement. ton miles.	Av. rate per ton pass. mile.	Av. rate per ton mile.
Lines East of Chicago:	M.	1 = 1,000.	Cts.	Cts.	M.	1 = 1,000.	Cts.	Cts.	M.	1 = 1,000.	Cts.	Cts.
Boston & Albany	250	227,151	2.09	2.81	298	375,452	1.21	2.68	305	462,241	1.14	1.86
L'k Shore & Mich. So'n	962	569,833	1.50	2.60	1,624	1,851,106	0.75	2.13	1,122	2,156,677	0.63	2.25
Mich. Cent	284	132,903	1.98	2.40	270	735,611	0.84	2.13	276	1,339 918	0.69	2.28
New York Central	737	709,087	1.88	2.09	735	2,525,139	0.87	2.00	819	2,973,598	0.76	1.96
N. Y., L., E. & W	459	898,862	1.33	2.34	526	1,721,112	0.84	2.04	548	3,518,487	0.64	1.66
Pennsylvania	404	825,979	1.55	2.49	452	2,296,317	0.88	2.25	458	6,984,332	0.65	2.08
Pitts., F. Wayne & Chic	468	336,084	1.46	2.40	468	80o,257	0.92	2.16	469	1,225,877	0.69	2.25
Totals	3,566	3,759,902	1.61	2.38	3,795	10,313,056	0.87	2.24	3,995	18,612,133	0.63	2.04
West and Northwestern Lines:												
Chic. & No'w'n	892	364,747	3.09	3.29	1,627	865,909	1.49	2.79	4,250	2,000,182	0.98	2.17
Chic., Bur. & Quincy	603	147,409	3.06	3.27	2,771	*1,250,000	1.28	2.75	5,137	1,978,806	0.95	2.18
Chic., Mil. & St. P	1,018	181,428	2.80	3.90	3,803	504,876	1.76	2.84	5,656	1,842,789	0.99	2.33
Chic., R. I. & Pac	544	130,683	2.74	4.06	729	664,861	1.21	2.81	1,185	1,157,420	1.02	2.28
Chic., St. P., M. & Omaha	....	....	....	....	963	209,790	1.40	2.44	1,324	481,397	1.01	2.45
St. P., Minn. & Man	283	5,941	4.16	3.40	860	93,330	2.88	3.23	2,774	554,752	1.27	2.42
Totals	3,250	830,210	2.61	3.52	10,754	3,586,768	1.44	2.75	20,329	8,015,439	1.00	2.27
Southwestern Lines:												
Atch., Top. & S. Fé	509	24,958	3.23	5.05	1,687	267,355	2.43	3.35	4,582	1,769,828	1.23	2.23
Chic. & Alton	322	*145,000	2.42	4.80	389	481,474	1.21	2.08	548	519 689	0.88	1.79
Mo., Kan. & Tex	342	34,512	4.49	4.71	786	188,024	1.65	3.38	1,652	580,558	1 11	2.78
Missouri Pacific	283	69,455	3.00	4.85	501	282,933	1.42	2.86	1,194	969,589	0.95	1.94
St. L. & San Fran	332	80,297	3 74	4.03	380	109,178	1.99	3.57	1,044	375,518	1.24	2.46
St. L., Iron Mt. & S'n	210	*41,750	2.19	4.85	684	263,223	2.08	2.77	1,208	716,884	1.11	2.46
Totals	1,998	395,974	2.95	4.58	4,520	1,592,188	1.65	2.80	10,229	4,938,069	1.11	2.30
Southern Lines:												
Ches. & Ohio	227	7,213	4.99	4.71	436	230,219	0.87	2.85	800	1,006 323	0.54	2.06
E. Tenn., Va. & Ga	270	*15,750	4.41	4.00	553	*121,000	1.75	3.50	1,302	535,886	0.87	2 46
Ga. R. R. & Bank. Co	232	*31,043	3.00	3.95	307	49,961	2.13	3.00	302	81,651	1.47	2.40
Illinois Central	707	265,409	1.74	3.14	918	381,288	1.34	2.51	2,275	1,189,282	0.95	2.08
Louisv'e & Nashv'e	381	57,885	2.97	3.78	872	319,690	1.61	3.72	1,276	1,250,836	0.98	2.42
Norfolk & W'n	428	48,751	2.89	3.90	428	98,595	1.50	3.44	1,060	1,003,892	0.57	2.86
Rich. & Danville	142	7,545	5.37	3.79	152	59,074	2.16	3.21	170	*4r 5,000	0.77	2.45
Nashv'e, Chatt. & St. L	173	*31,500	3.01	3.75	453	101,955	1.47	1.27	652	215,080	1.15	2.57
Totals	2,561	465,099	2.39	3.62	4,121	1,362,384	1.16	2.16	7,840	5,767,904	0.80	2.30
Transcontinental Lines:												
Northern Pac	....	....	....	....	1,045	80,949	1.95	3.88	2,364	1,095,880	1.40	2.55
Southern Pac	1,446	*80,000	4.70	5.00	2,890	565,063	4.01	3.75	6,225	1,754 139	1.61	2.18
Union Pac	1,038	71,779	4.26	5.00	1,820	783,331	1.99	3.38	1,821	2,330,147	1.38	2.34
Totals	2,485	151,779	4.50	5.00	5,756	1,429,344	2.21	3.61	10,412	5,180,166	1.50	2.33
RECAPITULATION.												
Lines East of Chicago	3,566	3,759,902	1.61	2.38	3,895	10,313,056	0.87	2.24	3,995	18,612,133	0.63	2.04
West and Northwestern Lines	3,250	830.210	2.61	3.52	10,754	3,586,768	1.44	2.75	20.329	8,015.439	1.00	2.27
Southwestern Lines	1,998	395,974	2.95	4.58	4,520	1,592,188	1.65	2.80	10,229	4,938,069	1.11	2.30
Southern Lines	2,561	465,099	2.29	3 62	4,121	1,362 384	1.16	2 16	7.840	5,767,904	0.80	2.30
Transcontinental Lines	2,485	151,779	4.50	5.00	5,756	1,429,344	2 21	3.61	10.412	5.180,166	1.50	2.33
Totals	13,862	5,602,963	1.99	3.05	28,948	18,283,743	1.17	2.58	52,807	42,513,742	0.91	2.19

*Estimated

Table 4.—Showing, by Groups of States, the Mileage, Equipment, Liabilities, and Assets, Mileage Operated, Traffic Operations, Gross and Net Earnings, Interest and Dividend Payments, etc., etc., of all of the Surface Steam Railroads in the United States at the Close of their Respective Fiscal Years Ending in 1891 and 1890.

	U. S. 1891. Miles.	New Eng. 1891. Miles.	Middle. 1891. Miles.	North. Central. 1891. Miles.	So. Atl. 1891. Miles.	So. Cent 1891. Miles.	South'wn. 1891. Miles.	North'wn. 1891. Miles.	Pacific. 1891. Miles.
Mileage of Railroads	167,845	7,046.40	19,692.48	48,135.53	17,871.15	12,068.56	32,168.11	21,429.84	9,433.49
Second track, sidings, etc	46,683	3,837.78	15,214.78	13,646.52	2,189.30	2,199.80	4,929.46	3,265.23	1,570.42
Total track	214,528	10,884.18	34,907.26	61,782.05	20,060.55	14,268.46	37,097.57	24 725.07	10,803 91
Steel rails in track	174,775	8,616.40	29,505.53	51,498.64	16,138.79	11,559.64	29,186.28	19,781.69	8,488.77
Iron rails in track	39,753	2,267.78	5,401.73	10,283.41	3,921.66	2,709.42	7,911.29	4,943 38	2,315.14
	No.	No.	No.	No.	No.	No.	No.	No.	No.
Locomotive engines	33,563	2,473	9,228	9,946	2,318	1,937	4,103	2,624	934
Cars: Passenger	23,083	3,250	7,710	5,264	1,404	1,089	2,138	1,212	1,014
Baggage, mail, etc	7,368	680	1,859	2,003	682	418	919	528	279
Freight	1,110,286	54,464	370,124	348,872	56,535	63,007	113,869	81,834	21,581
Total revenue cars	1,140,737	58,394	379,693	356,139	58,621	63,514	116,926	83,574	22,876
Liabilities:	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,00
Capital stock	$4,751,750	242,120	1,060,648	1,192,877	374,547	306,024	816,413	427,546	322,270
Bonded debt	5,178,821	168,559	1,144,185	1,373,827	349,892	348,064	914,906	618,158	261,227
Unfunded debt	345,102	22.168	96,742	93,599	24,852	18,828	40,319	37,023	1,577
Current accounts	374,051	15,432	121,206	71,623	20,901	17,720	57,818	64.067	5,290
Total liabilities	10,649,726	448,281	2,431,782	2,731,919	780,193	660,638	1,829,457	1,147.095	590,356
Excess of assets over liabilities	341,697	16,428	97,250	111.115	2,191Def.	1,690	5,233	51,905	59,202
Total	10,991,423	464,710	2,529,033	2,843,035	782,384	688,948	1,834,691	1,199,061	649,558
Assets:									
Cost of railroad and equipment	8,927,571	388,908	1,857,417	2,444,722	674,762	607,172	1,362,304	973,553	618,640
Real estate, stocks, bonds, and other investments	1,588,590	49,206	524,599	304,028	75,139	61.947	306,003	156,034	20,971
Other assets	233,862	16,294	74,367	55,437	14,485	10,919	22,698	34.615	4.945
Current accounts	241,399	10,141	72,649	38.246	17,997	8 908	53,595	34.858	5,001
Total assets	10,991,423	464,710	2,529,033	2,843,035	782,384	688,948	1,834,691	1,199,061	649,558
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
Miles of railroad operated	164,261	7,315	19,693	51,426	16,648	10,731	29,828	20,299	8,319
Revenue train mileage:	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,0 0	1=1,000	1=1,000
Passenger	320,712	29,788	83,604	98,750	19,961	16,973	32,632	23,891	15,120
Freight	493,541	24,701	131,997	168,709	28,243	27,003	55,380	42,035	15,409
Mixed	16,948	320	2,977	2 736	3,481	2,190	3,880	503	657
Total	831,202	55,110	218,578	270,256	51,686	46,167	91,883	66,432	31,188
Passengers carried	556,015	118,502	221,138	116,694	18,576	18,039	23,020	16,831	22,601
Passenger mileage	13,316 925	1,857,802	3,850,100	3,644 184	656,188	587,241	1,080,625	973,961	686,822
Tons of freight moved	704,308	42,577	294,964	204,432	37,119	41,127	39,127	33,155	11,894
Freight mileage	81,316,154	2,922,201	26,358,758	27,567,895	4,397,099	4,016,569	6,989,199	6,748,708	2,209,722
	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,000	1=1,00.0
Traffic earnings: Passenger	290,799	34,740	72,857	81,326	17,411	15,196	28,912	22,635	17,518
Freight	754,185	39,700	206,731	222,857	42,829	40,519	94,033	72,155	35,378
Miscellaneous	80,549	5,123	17,931	24,710	5,907	4,301	11,671	6,360	4,552
Total	1,125,534	79,564	297,519	329,075	66,238	59,917	134,617	101,151	57,449
Net earnings	350,807	21,698	97,678	100,844	19,596	19,078	33,711	36,596	21,003
Receipts from other sources	101,139	6,370	41,451	9,513	5,076	3,651	2,759	14.840	10,486
Total available revenue	451,947	28,068	139,150	110,358	24,672	22,730	43,470	51,397	32 089
Payments:									
Rents, tolls, etc	64,243	6,767	28,358	11,717	1,736	1,651	2,656	7,024	4,332
Interest on bonds	222,652	8,308	53,822	60,322	15,077	13,271	31,160	27,626	13,113
Other interest	5,917	434	2,527	1.369	248	133	941	102	99
Dividends on stocks	89,009	11,542	32,451	26,706	4,216	3,128	3,225	4,569	3,258
Miscellaneous	31,008	455	6,234	4,649	2,011	956	4,769	6,902	5,089
Total payments	412,921	27,509	123,394	104,764	23,290	19,140	42,642	46,284	25,894
Balance, surplus, or deficit	s 39,025	s 559	s 15,765	s 5,593	s. 1,382	s. 3,589	828	s, 5,112	s. 6,195

Note.—The statistics of elevated railways in the State of New York are omitted from the above table.

Table 2.—Showing by Groups of States Gross and Net Earnings, Average Receipts per Freight and Passenger Train Mile, per Ton of Freight per Mile, per Passenger per Mile, Average Freight and Passenger Train Load, Freight and Passenger Earnings per Mile of Railway, Ratio of Expenses to Earnings, Interest and Dividend Payments, etc., etc., of all Steam Surface Railways in the United States, from 1882 to 1891, inclusive.

	Freight earnings.						Passenger earnings.						Earnings per mile of ry.				
Years.	Gross amount 1 = 1,000.	Av. receipts per ton per mile.	Av. receipts per fr. ight train mile.	Av. receipts per mile of ry.	Av. train load, tons.	Av. haul per ton.	Length of railways in operation.	Gross amount 1 = 1,000.	Av receipts per passenger per mile.	Av receipts per passenger train mile.	Av. receipts per mile of ry.	Av. train sengers.	Av. distance traveled per pass.	Gross.	Net.	Ratio of expenses to earnings.	Interest paid on total bonded debt.	Dividends paid on total share capital.
	$	Cts.	Cts.	$		Miles.	Miles.	$	Cts.	Cts.	$		Miles.	$	$	P. c.	P. c.	P. c.
Group 1.—New England States: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.																		
1882 ...	28,57.	1.70	158.72	4,616	93.31	58.7	6,191	23,903	2.12	121.55	3,796	57.25	16.	9,076	2,663	70.66	5.19	4.40
1883....	30,436	1.68	156.18	4,907	98.67	58.6	6,203	25,532	2 15	127.62	4,116	59.37	16.3	9,537	2 435	74.47	4.86	4.32
1884....	29,450	1.59	164.92	4,597	108.67	59 8	6,4'7	25,678	2.06	119.91	4,008	58.24	16.3	9,143	2,578	71.80	5.27	4.45
1885....	28,3'7	1.56	159.84	4,371	101.95	59.8	6,476	25,'99	2.00	117.00	3,721	58.52	15.9	8,866	2,698	69.57	5.32	4.49
1886....	31,085	1.56	176.08	4,831	113.16	59.2	6,430	26,977	1 99	119.74	4,195	60.05	15.8	9,733	3,088	68.27	4.78	4.68
1887....	31,539	1.57	170.36	4,866	108.78	60.8	6,890	29,116	1.96	122.18	4,226	62.20	15.8	9,923	2,881	70.94	5.07	4.47
1888....	3.,357	1.52	171.72	5,126	115.76	62.7	6,702	30 611	2.01	119.30	4,567	59.38	15.3	10,008	2,499	75.03	4.56	4.82
1889....	36,630	1.46	173.02	5,263	118.24	65.7	6,830	32,443	1.97	120.46	4,750	61.16	15.0	10,565	2,957	72 01	5.0'	4.18
1890....	39,397	1.37	165 78	5,611	120.71	69 4	7,011	33,471	1.92	118.82	4,767	61.97	15.5	11.132	3,166	71.56	4 99	4.70
1891....	39,700	1.36	160.72	5,427	118.30	68.6	7,316	34,740	1.89	116.63	4,249	61.70	15.5	10,875	2,966	72.73	4.94	4.77
Group 2.—Middle States: New York, New Jersey, Pennsylvania, Delaware and Maryland.																		
	$	Cts.	Cts.	$		Miles.	Miles.	$	Cts.	Cts.	$			$	$			
1882....	147.987	1.04	162.67	9,618	181.34	98.7	15,387	51,530	2.29	97.22	3,348	42.51	18.8	13 164	4,606	65.01	4.75	3.43
1883....	166.489	1.04	157.15	10,534	151.49	86.3	15,805	53,856	2.17	99.97	3,408	45.02	19.5	13,785	5,299	61 78	5.99	3.65
1884....	150.590	0.94	154.32	8,674	161.26	94.0	17,361	54,286	2.12	94.49	3,117	39.84	18.6	12.429	4,313	65.25	5.18	3.54
1885....	146.497	0.84	151.49	8,233	179.42	91.5	17.794	51,'30	1.91	85.01	2.880	44.44	18.4	11.495	4.035	64.90	5.29	2.75
1886....	160.175	0.90	154 09	6,472	175.85	85.6	17.951	58,215	2.11	101.99	3.243	48.36	16.8	12.681	4,725	62.79	5.86	2.68
1887....	184.046	0.91	167.81	9.656	184.68	86 1	18,977	64,203	2.10	96.38	3,383	45.94	17.3	13,624	5,072	62.77	5.40	2 77
1888....	188,796	0 83	160.68	10,089	192.87	88.9	18,750	64,128	2.14	81.26	3,420	38.01	17.1	14,045	4,964	64.65	4.55	2.60
1889....	190,175	0.81	155.37	10,035	191 29	89.2	18,951	67 001	2.02	89.78	3,536	44 55	17.3	14,019	4,712	66.39	4.74	2.54
1890....	203,904	0.79	151.72	10,557	191.13	87.7	19,314	70,539	2.02	88 84	3,652	44.36	16.8	15,129	4,908	67.57	4.72	2.59
1891....	206,731	0.78	156.62	10,497	199.69	89.3	19,694	72,851	1.89	87.15	3.699	46.05	17.4	15.167	4,959	67.17	4.49	2.87
Group 3.—North Central States: Ohio, Michigan, Indiana, Illinois and Wisconsin.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$				
1882....	159.148	1.03	143 11	4,649	129.54	137.3	34,236	58,283	2.35	103.56	1,702	43.94	35.2	6,673	2,532	62.12	4.34	3.37
1883....	177,192	1.04	140.60	4,555	135.60	144 4	38,963	65,494	2.36	103.85	1,683	43.93	39.1	6,588	2,742	65.20	4.74	3.03
1884....	162.842	0.93	135.99	4,023	145.93	145.0	40,476	61,956	2.25	91.96	1.530	40.84	36.7	5,973	2,028	66.05	4.35	2.75
1885....	169.948	0.89	124.61	4,027	139.28	141.4	42,199	69,128	2.17	85.82	1.425	38.55	37.7	5,804	1.898	67 27	4.37	2.48
1886....	176,905	0.88	132.35	4,107	151.08	140.1	43,069	62,173	2.24	88.04	1,444	39.36	36.3	5,984	2,138	64.27	4.38	2.57
1887....	198,674	0 85	138.39	4,510	162.07	140.3	44,055	68,855	2.27	91.36	1,568	40.17	34.6	6,479	2,285	64 74	4.54	2.92
1888....	191,247	0 81	130.59	4,427	161.53	138.8	47,484	72,038	2.14	86.82	1,518	40.50	35.0	5,942	1,750	70 50	4.51	2.37
1889....	201,345	0.81	135.12	4,304	167 16	135.4	49,056	74,101	2.05	84.78	1,510	41 34	35.3	6.041	1,923	68 17	4.47	2 17
1890....	221,857	0.79	134.05	4,256	168.52	136.2	50,93	75,931	2.28	82.74	1,490	37.46	32 0	6,267	1,905	69.59	4.44	2.26
1891....	222,837	0.81	132.04	4,333	163 35	134.8	51,426	81,526	2.24	82.56	1,585	36.90	31.2	6,399	1,961	69.36	4.39	2.24
Group 4.—South Atlantic States: Virginia, West Virginia, North Carolina, South Carolina, Georgia and Florida.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$			
1882....	19,775	1.71	142.41	2,424	82.98	103.3	8,162	7,721	2.69	96.65	946	35 93	49.6	3.674	1,129	69.26	3.33	1.59
1883....	23,365	1.81	143.23	2,619	75.13	94.6	8,921	8,678	2.94	89.08	927	30.18	42.0	3.867	1,260	67.40	4.16	1.44
1884....	21,522	1.53	103.72	2,363	67.61	103.5	9,107	9,052	2.74	72.94	994	26.56	42.9	3,643	1,144	68.62	3.94	1.08
1885....	23,154	1.35	126.31	2.247	93.45	107 7	10,706	9,958	2.71	87.08	975	32.15	39.7	3,502	1,103	67.47	3 60	0.90
1886....	26,047	1.22	142 30	2 478	116.70	118.8	10,551	9,474	2.26	85.17	924	37.55	45.1	3,600	1,171	62 20	3.84	0.89
1887....	28,516	1.23	143.90	2,432	116.69	109.0	11,739	11,005	2.78	84.07	9-7	30 27	35.0	3,740	1,163	68.04	3.46	0.69
1888....	31,204	1.18	153.23	2,616	128.97	104.5	11,927	12,311	2.82	89.82	1,032	34.87	34.5	3,894	1,057	72.85	3.54	0.64
1889....	32,159	1.10	143.63	2,477	130.45	111.4	12,985	11,739	2.64	76.84	904	29.13	33.6	3,711	1,043	71.91	3.68	0.90
1890....	40,563	1.03	147.97	2,787	143.07	111.4	14,555	15,723	2.55	83.13	1,080	32.64	36.5	4,183	1,245	70.23	3.50	0.91
1891....	42,829	0.97	151.64	2,573	155.69	118.4	16,648	17,411	2.65	87.23	1,046	32.87	35.3	3,979	1,177	70.51	4.31	1.13
Group 5.—South Central States: Alabama, Mississippi, Tennessee, Kentucky and Louisiana.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$			
1882....	18,442	2:06	101.68	3,124	49.30	94.7	5,903	7,350	2.67	96.94	1,245	36.30	52.1	5,085.39	1,911.07	65.42	3.44	0.64
1883....	22,611	1.66	109.45	3,292	66.10	96.1	6,838	8,923	2.67	91.54	1,305	34.18	44 6	5,191.37	1,946.80	62.87	3.84	0.29
1884....	22,688	1.49	97.61	3,805	65.30	100.3	8 087	12,455	2.74	119.13	1,510	43.48	46.6	4,651.51	1,620.45	63.72	3.92	0.14
1885....	28,097	1.43	179.19	3,023	125.34	102.4	9,294	10,745	2.24	96 17	1,156	43.01	47.7	4,339.36	1 450.11	66.60	4.05	0.28
1886....	26,047	1.31	169.88	3,169	129.83	104.5	8,219	9,469	2.51	92.65	1,152	36.98	43.4	4.619.41	1.534.34	66.87	3.77	0.24
1887....	31,590	1.24	162.57	3 710	130.90	102.4	8,514	10.623	2.42	89.92	1,248	45.60	38.5	5,274.30	1,817 32	65.55	3.91	0.23
1888....	31,056	1.09	148.82	3,333	137 06	98.2	9 323	11.6 6	2.49	86.38	1,251	31 50	35.8	4,967.73	1,668.06	66.44	3 08	0.79
1889....	33,537	1.07	154.60	3,454	144.19	97.1	9,709	11,772	2.49	85.35	1,213	34.22	32.2	5,026.37	1,713.25	65.91	3.63	1.10
1890....	37,505	1.04	154.55	3,920	149.98	98.3	9,569	13,262	2.46	86.48	1,386	35.10	33.0	5,703.01	1,986 43	65.17	4.40	1 23
1891....	40,519	1.01	150.06	3,776	148.74	97.6	10,731	15,196	2.59	89.54	1,416	34.60	32.5	5,583.63	1,777.92	68.16	3.81	1.02
Group 6.—Southwestern States: Missouri, Arkansas, Texas, Kansas, Colorado and New Mexico.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$			
1882....	46,762	1.93	193.93	2,918	101.66	152.8	13,962	12.945	3.25	85.92	928	26.42	59.5	5,069	2,272	59.98	4.72	1.492
1883....	62,954	1.88	168.89	3,926	89.64	168.3	16,039	19,907	3.07	115.60	1,241	37.62	60.6	5,611	2,247	59.06	4 92	1.40
1884....	57,543	1 74	200.99	2,725	115.31	147.0	21,112	20,297	3.26	128.07	961	39.54	49.5	4,031	1,397	63.81	3.92	1.20
1885....	63,796	1 74	206.01	3,265	118.31	132.3	19 541	20,489	2.93	105.31	1,049	35.97	48.9	4.668	1.693	63.73	4.26	1.30
1886....	67,411	1.56	190.90	3.322	122.21	143 7	20 257	21,327	2.60	98.68	1 053	37 89	50.7	4,733	1,660	64.92	4 11	1.31
1887....	77,320	1.53	183.65	3.364	120.11	149.1	22,987	26,092	2.82	106.87	1,135	37.84	50.1	4.873	1,676	65.60	4.04	1.83
1888....	73,314	1.47	160.68	2,912	108.99	138.4	26,070	26,091	2.52	9'.13	1,001	37.43	46.7	4,140	1.027	75.19	4.21	0.82
1889....	78,596	1.21	167 70	2,799	120.30	148.8	28.076	25,701	2.60	48.10	916	32.29	42.7	4.081	1.149	71.84	3.51	0.79
1890....	91,178	1.35	179.97	3.216	133.15	176.2	28,356	27,709	2 64	94.78	977	35.95	44.7	4,562	1,322	71.01	3.12	0 40
1891....	94,033	1.35	169.80	3,153	126.20	178.6	29,328	28,912	2.68	88.63	969	33.13	45.7	4.513	1,130	74.95	3.40	0.40
Group 7.—Northwestern States: Iowa, Minnesota, Nebraska, North Dakota, South Dakota, Wyoming and Montana.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$			
1882....	32,410	1.93	216.76	4,655	112.02	208.2	6,961	11,135	2.98	158.83	1,599	52.89	110.8	6,829	2,998	56 11	5.33	2.52
1883....	37,944	1.79	214.60	4,236	119.76	168.2	8,956	12,618	3.03	149.15	1,409	49.16	68.3	6,042	2,382	57.27	3.90	2.37
1884....	37,382	1.58	208.27	3 640	132.03	177.5	10,269	13,968	3.09	140.98	1,360	45.59	72.4	5,369	2,290	57.34	4.71	1.34
1885....	39,091	1.48	218 67	3,402	147.62	159.1	11,666	12,705	2.61	123.06	1,089	47.22	59 8	4.791	2.040	57.42	5.13	0.92
1886....	41,375	1.42	220.68	3,356	155.25	156.0	12.330	13.365	2.51	116.83	1,086	46.47	54.0	4.715	1.892	59.88	5.11	0.90
1887....	50,880	1.39	197.49	3,820	158.96	161.1	15,325	16,542	2.69	120.14	1,079	44.62	45.5	4,721	1.844	60.94	4.76	0.97
1888....	51,574	1.21	194.15	3,240	179.90	180.1	15.916	17.966	2.59	112.72	1,129	43.46	44.3	4.644	1,719	62.99	3.95	0.53
1889....	58,587	1.26	186.66	2,964	148.51	191.6	19,700	20,770	2.56	106.99	1,054	41.06	56 2	4,267	1,512	64.56	4.35	0.49
1890....	67,745	1.06	160.35	3,248	150.69	201.3	20,829	22,091	2.21	91.26	1,059	41.04	60.6	4,587	1,587	65.40	4.57	0.75
1891....	72,155	1.07	171.65	3,555	160.54	203.5	20,299	22,635	2.32	94.74	1,115	40.77	57.8	4,983	1,803	63.82	4.47	1.07
Group 8.—Pacific States: Washington, Oregon, California, Nevada and Arizona, Utah and Idaho Territories.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$			
1882....	24,676	2.03	242 11	4,978	119.19	219.7	4,955	10,832	3.09	215.76	2,186	70.10	33.4	7,870	2,729	65.30	4.41	2.44
1883....	23,514	2.21	273.44	4,479	123.52	209.3	5,274	11.825	2.84	228.30	2,242	80 29	35.0	7,292	2,677	63.29	5.69	2.67
1884....	20,057	2.53	257.03	3,744	110.31	182.0	5,363	11,095	3.08	219.34	2,069	67.97	33.9	6,252	2,550	59.21	4.52	1.75
1885....	20,228	2.27	261.69	3,467	115.19	161 7	5,875	10,517	2.63	182 45	1,892	69.41	31.2	5,687	2,519	55.71	6.86	0.61
1886....	22,583	2.28	321.51	3,562	144.92	180.5	6,340	10,577	2.61	187.26	1,668	71.98	32.0	5,813	2,527	56.52	3.77	0.73
1887....	32,108	1.26	227.06	3,820	179.81	213.6	8,405	14.283	2.28	144.86	1,699	63.61	38.0	6,205	2,455	60.42	4.68	0.72
1888....	37,608	1.69	279.77	4,130	165.24	174.0	9,168	16,511	2.47	170.75	1,801	69.18	38.5	6,686	2,346	64.91	5.94	0.62
1889....	35,128	1.74	279.89	4,191	157.69	140.9	8,381	15,307	2.40	143.72	1,898	60.60	31.8	6,966	2,465	64.61	5.40	1.01
1890....	39,729	1.56	223.09	4,437	142.79	111.5	7,576	13,641	2.21	123.03	1,800	60.18	36.9	7,258	2,586	64.37	5.99	1.04
1891....	36,378	1.60	229.59	4,253	143.40	125.7	8,319	17,538	2.25	115.85	2,106	45.42	30.3	6,906	2,597	62.40	5.02	1.01
Total, United States and Territories.																		
	$	Cts.	Cts.	$				$	Cts.	Cts.	$			$	$	p. c.	p. c.	p. c.
1882....	485,778	1.236	159.21	5,074	128.81	109.0	95,752	188,137	2.447	113.72	1,904	46.47	26.6	7,377	2,670	63.61	....	2.91
1883....	539,569	1.224	154.09	5,045	123.86	110.0	106,938	206,837	2.422	110.07	1,934	45.45	27.3	7,461	2,702	63.78	....	2.75
1884....	502,869	1.125	150.19	4,443	133 58	112.0	113,173	206,790	2.356	100.13	1,837	42.50	26.2	6.633	2,318	65.21	4.66	2.48
1885....	509,690	1.036	148.91	4,174	143.59	112.4	122,189	220,883	2.198	94.94	1,645	43.16	25.9	6,365	2,185	65.12	4.77	2.02
1886....	550,359	1.042	157.34	4,397	150.99	109.4	125,146	211,929	2.194	100.61	1,693	45.85	25.2	6,570	2,376	63.84	4.75	2.04
1887....	636,606	1.034	161.51	4,647	156.16	111.5	136,986	240,542	2.276	100.75	1,756	44.27	24.6	6,861	2,444	64.45	4.71	2.18
1888....	639,200	0.977	155.71	4,388	159.36	110.7	145,341	251,356	2.246	93.74	1,729	41.73	24.7	6.540	2,045	68.72	4.35	1.77
1889....	665,992	0.970	155.06	4,333	159 91	110.9	153,689	259,439	2.169	92.96	1,688	42.87	24.1	6.455	2,068	67.95	4.40	1.81
1890....	734,821	0.927	152.17	4,651	163.99	114.5	157,976	272,320	2.174	91.61	1,724	42.12	24.0	6,829	2,162	68.33	4.27	1.89
1891....	754,185	0.929	152.81	4,591	164.55	115.2	164,262	290,799	2.184	90.67	1,770	41.52	23.9	6,852	2,136	68.83	4.25	1.85

ancy exists, but from an examination of the totals by states it seems almost certain that it has included track laid on railways doing only freight business (logging and mineral roads), and therefore excluded from our figures. As stated in connection with the statistics in our issue of Jan. 23, 1892, the total mileage there given could have been easily increased two or three hundred miles by including logging and mineral roads and short spurs to mills and factories.

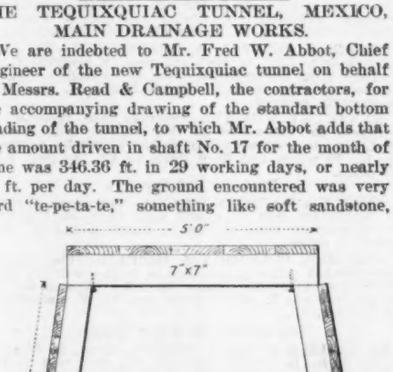
In closing it is proper to call attention to the publishers' statement that, as in the 1891 issue of the Manual, much matter heretofore given in the Manual relating to street and private railways, and railways in foreign countries, will be published in a separate volume entitled "Poor's Directory of Railway Officials."

Table 1.—Showing the Average per Mile of Stock, Bonds, Cost and Earnings, Percentage of Expenses to Earnings, Earnings per Passenger Train Mile and per Freight Train Mile, per Passenger Mile and per Tonnage Mile, &c., for U. S. Railways, for years 1885 to 1891 Inclusive.

	1891.	1890.	1889.	1888.	1887.	1886.	1885.
Capital stock per mile of completed road	$ 8,641	$ 8,333	$28,095	$28,768	$28,341	$29,935	$29,867
Bonded debt " " " "	31,179	31,244	30,178	29,972	28,290	29,062	29,453
"Cost of road and equip't" per mile completed road.	53,648	53,783	53,740	54,008	52,699	54,301	55,039
Passenger earnings per mile road in operation	1,770	1,723	1,688	1,729	1,756	1,693	1,612
Freight earnings " " "	4,991	4,651	4,393	4,397	4,649	4,397	4,219
Gross earnings " " "	6,926	6,916	6,524	6,540	6,861	6,570	6,265
Net earnings " " "	2,168	2,195	2,095	2,045	2,444	2,376	2,185
Percentage of expenses to earnings	68.83	68.33	67.95	68.72	64.45	63.84	65.12
Passenger earnings per passenger train mile	$0.907	$0.920	$0.932	$0.937	$1.008	$1.006	$0.949
Freight earnings per freight train mile	1.528	1.522	1.550	1.557	1.615	1.573	1.518
Gross earnings per revenue train mile	1.354	1.359	1.374	1.380	1.445	1.443	1.366
Gross expenses " " " "	0.932	0.929	0.934	0.948	0 931	0.921	0.892
Net earnings " " " "	0 422	0.434	0.440	0.432	0.514	0.522	0.474
Passenger earnings—Proportion of gross	per cent. 25.84	per cent. 25.24	per cent. 26.13	per cent. 26.44	per cent. 25.82	per cent. 25.77	per cent. 26.25
Freight earnings— " " "	67.00	68.12	67.13	67.24	68.38	66.94	67.90
Other earnings— " " "	7.16	6.64	6.71	6.32	5.80	7.29	5.85
Earnings per passenger per mile	Cents. 2.184	Cents. 2 174	Cents. 2.169	Cents. 2.246	Cents. 2.276	Cents. 2.104	Cents 2.198
Earnings per ton per mile	0.929	0.927	0.970	0 977	1.034	1 042	1 036
Average distance per passenger	Miles. 23.95	Miles. 24.05	Miles. 24.18	Miles. 24.79	Miles. 24.68	Miles. 25.27	Miles. 25.99
Average haul per ton	115.29	111.55	110.90	110.72	111.51	109.49	112.46
Interest per cent. of bonds	per cent. 4.25	per cent. 4.27	per cent. 4 40	per cent. 4.35	per cent. 4.71	per cent. 4.75	per cent. 4.77
Interest per cent. of bonds and debt	4.10	4.09	4.09	4.17	4.55	4.53	4 62
Dividends per cent of stock	1.85	1.80	1.81	1.77	2.18	2.01	2.02
Int. and div. per cent. of stock, bonds and debt	3.06	3.04	3.03	3.03	3.40	3.26	3.36

THE TEQUIXQUIAC TUNNEL, MEXICO, MAIN DRAINAGE WORKS.

We are indebted to Mr. Fred W. Abbot, Chief Engineer of the new Tequixquiac tunnel on behalf of Messrs. Read & Campbell, the contractors, for the accompanying drawing of the standard bottom heading of the tunnel, to which Mr. Abbot adds that the amount driven in shaft No. 17 for the month of June was 346.36 ft. in 29 working days, or nearly 12 ft. per day. The ground encountered was very hard "te-pe-ta-te," something like soft sandstone,



Standard Bottom Heading for Tequixquiac Tunnel, Mexico Main Drainage Works.

with a fair amount of water with it. It was necessary to "shoot it all," putting in five holes about 4 ft. deep, with 0.6 lb. of dynamite in each hole. It was also necessary to put in settings or bents, as shown, every 4 ft. The labor was entirely native.

Mr. Abbot accompanies these notes by an inquiry as to whether this rate of progress "compares favorably with other known records," but there are no other known records through similar material and under similar conditions with which to compare it, so far as we know. In our issue of Nov. 1, 1890, we gave the full section of the tunnel, of which the heading shown in the accompanying engraving is but a very small part, and there recorded that the past progress of the tunnel had been only 15 to 20 m. (50 to 63 ft.) per month, which will be seen to be very far below the present record; and we think we are safe in saying that no other tunnel heading has ever been driven at the mean rate of 12 ft. per day or over except the Channel tunnel through dry chalk, and a few others through favorable and dry rock. The rate given is at the rate of 4,380 ft. per year per heading, which is certainly enormous.

In our issue of Aug. 10, 1889, we gave a longitudinal section of the tunnel, from which it will be seen that shaft 17 is the deepest one of them all, being some 350 ft. deep.* The total length of the tunnel, which really consists of two parts, known respectively as the Zumpango (6,200 m.) and Tequixquiac (9,521 m.) tunnels, is 15,721 m., or 9.76 miles, making it the longest tunnel in the world, the new Croton aqueduct tunnel (30 miles) alone excepted.

DRAINAGE OF MICCOSUKEE LAKE, FLA.

The reclamation of swamps and drainage of lakes in Florida has been for some time exciting considerable interest. Great areas in that state are capable of reclamation, and become rich and valuable lands. There are numerous projects under way, and the success attending those already undertaken is very encouraging. Among others, Mr. J. Francis Le Baron, M. Am. Soc. C. E., of Jacksonville, Fla., is now engaged in making surveys and estimates for the drainage of Miccosukee Lake, containing 9,000 acres, in Jefferson and Leon counties, and we are indebted to him for the following notes of the work. There will be 11 miles of main canal and 14 miles of branch canals. One hundred and seventy-three borings have been taken which show a top stratum of black muck from 2 ft. to 6 ft. in depth and a substratum of clay and soft phosphate. The analysis of the soil made by the Agricultural Department at Washington shows it to be very fertile and especially rich in ammonia. This part of the state (the northwest center, about Tallahassee), abounds in "sinks," which are large holes into which considerable streams empty and disappear in the bowels of the earth, and a unique feature of the work is the drainage of the entire lake into two of these sinks. The canals will be dug into these sinks, which it is expected will take off all the water from the lake and its drainage area.

Measurements of the water flowing into these sinks has been made by Mr. LeBaron and his assistants at a time of nearly maximum flood. The sinks are so large that whole pine trees, 70 to 80 ft. in height, with all their roots and branches, have been engulfed and entirely swallowed up. The roar of the engulfing waters is heard for a long distance, and the water rushes down in a circular swirl resembling the famed Norway maelstrom of the earlier geographers.

It has been suggested that these numerous sinks are passages extending into the Gulf of Mexico, and they are of such magnitude that there has even been a local theory that they gave birth to the Gulf Stream, whose origin has puzzled geographers so much. While this theory is, of course, absurd, it shows what a phenomenon these sink holes are.

An insecure feeling is naturally engendered in taking soundings in the ponds and lakes of this region, and even in camping on the borders, as it is known that the formation of these sinks is still going on. Only a few years ago the bottom of a small pond in this vicinity fell out, by the formation of a sink. The water dropped down and disappeared so suddenly as to leave the fish on the margins of the lake, with such a shock that the dishes and other articles were thrown down from the shelves in a house near the borders of the pond, and a large pine tree, some 80 ft. high was drawn down by the escaping water with the caving bank and left standing in a circular well of rock, with the top branches below the level of the bottom of the pond. The water ran out so completely that an adventurous countryman climbed down the tree nearly to the bottom a few hours after the occurrence, and reported that he could hear the rush of water below, flowing toward the Gulf of Mexico. This whole statement, Mr. Le Baron assures us, is well authenticated. The subterranean channel has since closed, probably because of the immense inflow of mud and earth and timber, and the pond has filled up again, the pine tree being entirely out of sight, under water.

Other large works in the same vicinity, on which Mr. Le Baron himself has been engaged within the past year, are the drainage of Lake Okeechobee, the Sarasota (saw grass), the Halpati (saw grass; 112,000 acres), and the Okefinokee Lake in Georgia and Florida (403,200 acres). As there are still other engineers doing similar work in various parts of Florida, the magnitude which these reclamation works are assuming can be better understood.

*In this section the side scale is in feet and the depth for each shaft is given in meters. A note to this effect below the section should have been given, but was overlooked.

The ocean record has been again broken by 33 minutes by the City of Paris, which has crossed from Daunt's Rock to Sandy Hook light (the usual course) in 5 days, 15 hours and 58 minutes, or at the mean rate of 20.47 knots per hour. This was in spite of five hours' detention by fog, by which about 15 knots, or nearly 45 minutes time, was lost on the fourth day out. On two days she also broke the record for day's runs, making 519 and 520 knots against the Teutonic's record of 517 knots, the best before on record. The ultimate limit for ships of this speed, assuming 520 knots for every day's run and a course of 2,780 miles, is 5 days, 7 hours and 18¼ minutes, but such a favorable combination is hardly to be expected. The record of the four last record-breaking runs is as follows:

Day.	Paris, July 27,'92.	Teutonic, Aug. 19, '91.	Majestic, Aug. 5, '91.	Paris, Aug. 10, '89
First	478	460	470	432
Second	501	496	501	493
Third	519	505	497	502
Fourth	504	510	501	506
Fifth	520	517	491	509
Sixth	263	290	317	346
Total knots,	2,785	2,778	2,777	2,788
Time	5:15:58	5:16:31	5:18:08	5:19:18

The Canadian Niagara Power Co., which proposes to build a tunnel to secure water power from the Horseshoe Falls on the Canadian side of the Niagara River, has completed its organization, and the lease of the exclusive privilege to develop the power of the falls in Victoria Park, which was granted to A. D. Shaw, F. L. Stetson and W. B. Rankin, by the Park Commissioners, has been transferred to the new company. The officers of the company are: Pres., A. D. Shaw; Vice-Pres., F. L. Stetson, and Sec. and Treas., W. B. Rankin. The company will await the completion of the tunnel now under construction on the American side before beginning operations.

Road legislation has reached Congress in the shape of a bill introduced by Senator Manderson of Nebraska, providing for the establishment of a commission to exist for two years. The commission's duties are to formulate plans for a national school of roads and bridges, with branches attached to the various agricultural colleges and experiment stations; to consider the establishment, in connection with this school, of military or post-roads in some sections of the country; to report on what the United States has already done in the way of highway construction; and to make recommendations as to such roads as may still be under national ownership; to collect and disseminate information on the subject in general; to procure the exhibition at the World's Fair of road-making appliances; and afford free instruction in the art for all there who desire it; to collate the various state laws on the subject, with information as to their practical work-

ings and suggestions as to their modification; to inquire and report whether any form of national to indesirable, more particularly a co-operation between nation, state and county in a general system of construction, based upon mutual agreement as to need and character of work, joint supervision of its execution and the use of their joint credit to secure the money on favorable terms. The commission is also to investigate the practicability of employing convicts upon the roads and of regulating the construction of vehicles for the better preservation of road surfaces; and, finally, to report what state and national legislation or constitutional amendments are necessary, together with any other suggestions or recommendations concerning the subject that it sees fit to make. The bill is purely educational in character and merely provides fo a thorough investigation of the subject.

Aeration of the water supply of Brockton, Mass., is being tried. An air compressor forces about 160,000 cu. ft. of air per day, it is reported, through ¼ and ⅝-in. brass pipes in the bottom of the 1,300,000-gallon high service tank. The water supply is from an impounding reservoir on Salisbury Brook and aeration is used to improve its character.

Low water in the Schuylkill River, at Philadelphia, and in the city reservoirs has caused the city officials to take temporary measures to cut down the consumption by stopping public fountains, the flushing of gutters and street and lawn sprinkling. The Schuylkill has been so low that not more than two out of seven wheels at the water power pumping station could be run.

Railways built in the Argentine Republic in 1891 aggregated 1,012 miles of narrow gage, 246.75 miles of meter gage and 664.66 miles of broad gage, or 1,923.41 miles in all. Of this total, 646 miles were national guaranteed lines, 31.21 miles were provincial guaranteed lines, 905.20 miles were non guaranteed lines, and 341 miles were government lines.

Soap from the refuse oil extracted by cleaning cotton waste is being made by the locomotive department of the Bombay, Baroda & Central India Ry.

The French railways in northern Africa amounted to 1,930 miles 1891, with receipts of nearly $5,570,000. Four new lines, aggregating 144 miles, are projected.

The new suburban cars for the Staten Island Rapid Transit R. R. are 54 ft. 6 ins. long over all, 51 ft. 10 ins. long over the platforms, 9 ft. 6 ins. wide over the frames, 8 ft. 8 ins. high from floor to top of monitor roof, 12 ft. 8¾ ins. high from rail to top of monitor roof. They have seating capacity for 54 passengers, but carry 100 sitting and standing when crowded. The sliding doors are 4 ft. wide, and the platforms are wider than usual. There are no platform steps, as the stations have raised platforms level with the car platforms. The trucks have Paige steel tired wheels. The cars are painted blue and finished with mahogany inside. They are fitted with the Gold system of steam heating from the locomotive, Janney couplers, vacuum brakes and platform gates like those used on the cars of the New York elevated railways. The cars were built by the Jackson & Sharp Co., of Wilmington, Del.

Two double-screw ferryboats with steel hulls are being built for the Central R. R. of New Jersey. They are 143 ft. long between perpendiculars, 158 ft. long over all, 32 ft. beam of hull, 54 ft. width over guards. Each screw will be driven by an independent compound engine, with cylinders 16 × 22 and 30 × 22 ins. The boilers will carry a working pressure of 190 lbs per sq. in. The boats are being built by the Harlan & Hollingsworth Co., of Wilmington, Del.

The following proposals have been received by the Navy Department for the construction of a new timber dry dock at the Brooklyn, N. Y., Navy Yard, to be built alongside of the present Simpson dry dock. The bids were for a dock 600 ft. long, with 28 ft. of water, and included suction pump, drainage pump, floating gate or caisson, and other works, in accordance with plans prepared by the Engineer, Mr. Asserson. The bids were as follows: John Gillies, New York, $412,000; B. G. Bailey, $477,000; J. E. Simpson & Co., New York, $537,379; Justin McCarthy, Washington, D. C., $577,900 (and 8 cts. per lb. additional for pile shoes); R. G. Packard, New York, $586,000; P. J. Minitter, New York, $595,000; James J. Leary, New York, $620,000; John O'Rourke and Michael J. Daly, Brooklyn, N. Y., $663,000; F. Sanford Ross, Jersey City, N. J., $674,000.

Sanitary methods of street cleaning and garbage disposals are being established in Chicago. A garbage cremation ordinance has been passed by the Common Council, empowering the Health Commissioner to put in garbage crematories at a cost not to exceed $75,000 including maintenance. The office of superintendent of street cleaning has been established, the duties including the removal of garbage, ashes, manure, offal, etc., as well as street cleaning. Bids for cleaning are to be advertised for. The committee on street cleaning suggests to property owners in the down town districts that a system of paving the alleys with proper material and lighting the same would result in making available as business places for various kinds of trade the rear portions of their buildings, which are now, to a large extent, dead property. The committee further recommends that the attention of the Department of Public Works be called to frequent violations in the way of undue obstruction of streets with building material, etc., by parties who have permits for the use for a limited time of a specified portion of the streets, and urges that the ordinance covering the same be more strictly enforced. The committee has under discussion a new and comprehensive plan of accumulating and disposing of garbage, refuse, etc., which it will submit in the form of an ordinance.

A freight house has been designed for the elevated terminal at Chicago, which is to be built by the Chicago Elevated Terminal Co., of which Gen. Joseph T. Torrence is president (Eng. News, Jan. 2). The building is to be 346 ft. long, 134 ft. wide, and nine stories high. The first story is below the street level and is intended for cold storage. The eighth floor is intended to be largely used as auction rooms and is lighted from the roof. All of the stories are 15.6 ft. in the clear between the floors and the ceilings. The cars are received and dispatched from the second story, which is 20 ft. above the level of the street. By means of hydraulic capstans they are hauled one at a time upon two elevators, which have a lifting capacity of 75 tons, and run from the basement to the eighth floor. When the cars arrive at the floor at which it is desired to place them, by means of hydraulic capstans they are hauled off from the elevator and placed upon transfer tables.

The present production of aluminum is estimated to be about as follows:

	Lbs. per day.	
United States: Pittsburg Reduction Co.....	450	
Cowles Electric Smelting Co., Lockport, N. Y.....	450	900
England: Metal Reduction Co., Patricroft....	300	
Cowles Syndicate Co., Stoke-on-Trent.....	250	550
France: Minet Bros., St. Michael, Savoy.....		300
Switzerland: Falls of the Rhine.....		1,200
Total daily product.....		2,950
Equal to a yearly product of about.....		472 tons

The great Swiss works, by far the largest in the world, use 1,500 HP. in producing their daily product, or about 1.25 HP. per lb. of daily product, or about 320 lbs. of yearly product. The present price of aluminum is about 60 cts.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

GOUVERNEUR & OSWEGATCHIE.—About 400 men are now at work on this line from Gouverneur to Edwards, N. Y., 15 miles, and the force is to be increased. It is expected to have the line completed by Nov. 1.

OLD COLONY.—The engineers of this company have just completed the preliminary survey for a line from West Roxbury to South Framingham, Mass. As surveyed the line will start from a point near Spring St. Station in West Roxbury, cross the Charles River, near the Brookline pumping station and run through Dedham to Wendham, and thence to South Framington.

BALTIMORE & OHIO.—This company has awarded a contract to Jones & Thorne, of Baltimore, Md., for the construction of a double track tunnel, 875 ft. long, and a steel bridge, 700 ft. long, at Harpers Ferry, W. Va. Work will be commenced at once.

PENNSYLVANIA.—The 7-mile line from Pottsville to Minersville, Pa., has been completed and opened for traffic.—The Northern Central R. R. Co. is preparing to build large transfer yards at Lutherville and Timonium, Pa.

IRON RANGE & HURON BAY.—About 300 men are now at work on this line from Huron Bay, via Arvon and Dishno to Champion, Mich., 35 miles. The grading and bridging are finished and about 12 miles of track are laid. Work is now in progress on the docks at Huron Bay. It is expected to have the line completed by Oct. 1. Ch. Engr., E. D. Miller; Supt., Sanford Keeler; both of Arvon, Baraga Co., Mich.

LEHIGH VALLEY.—This company has acquired ten acres of land in the city of Buffalo, N. Y., which will be used for additional terminal facilities.

ALTOONA, CLEARFIELD & NORTHERN.—This company received bids on July 25 for building a branch from Coleman's Station to Altoona, Pa.

PHILADELPHIA & READING.—The people of Mt. Holly, Pa., are trying to induce this company to build a line from Philadelphia, Pa., to that place.

MIDDLESEX VALLEY.—A correspondent writes us that this road was graded from Geneva to Naples, N. Y., 30 miles, in 1875, under the name of the Geneva & Southwestern Ry. The present company was organized in 1892, and the road is being built by the Drake & Stratton Co., of New York City, under contract with the Seneca Construction Co., from a connection with the Northern Central R. R., at Stanley, N. Y., to Naples, N. Y., 22 miles. Tracklaying began from Stanley in June, and 11 miles are now laid; 60-lb. rails being used. The road is to be opened for traffic Aug. 25.

Projects and Surveys.

GIRADVILLE.—Chartered in Pennsylvania to build a railway from Shenandoah to Giradville, Schuylkill Co., Pa., 5 miles long. Pres., Henry D. Welsh, Philadelphia. The line is reported to be a branch of the Pennsylvania R. R.

TROY & NEW ENGLAND.—A recent meeting of the directors of this company was held to consider the construction of its proposed line from Troy, N. Y., to a connection with the Lebanon Valley R. R., about 35 miles. It is stated that an offer has been made by outside parties to build the road, and that if satisfactory arrangements can be made, construction will begin at once. The line has been surveyed once, but new surveys will be made. Pres., Walter P. Warren, Troy, N. Y. Sec., J. J. Tillinghast, Troy, N. Y.

NANTICOKE & NEWPORT.—This company has been chartered in Pennsylvania to build a railway eight miles long. Among the incorporators are: Thos. D. Shea, Nanticoke, Pa., C. H. Reynolds, Kingston, Pa., and John T. Lenahan, Wilkes Barre, Pa.

UNION TRANSFER & EXCHANGE.—Chartered in Pennsylvania to build a railway from the village of Library, Allegheny Co., Pa., to Layton Station, Fayette Co., Pa. Pres., Jas. B. Oliver, Pittsburg, Pa.

CHICAGO, INDIANAPOLIS & CHATTANOOGA SOUTHERN.—All but nine miles of the right of way has been secured between Rockport and Indianapolis, Ind., 172 miles. It is stated that a meeting of the directors will soon be held to make arrangements for beginning construction. Pres., D. P. Irwin, Indianapolis, Ind. Ch. Engr., J. H. McCormick, Columbus, O.

WHEELING & CONNELLSVILLE.—The surveys for this railway from Wheeling, W. Va., to Connellsville, Pa., is now nearly completed and work will soon begin on the maps and profiles.

Southern.—Existing Roads.

ROANOKE, FINCASTLE & CLIFTON FORGE.—Work has been resumed on this line between Fincastle and Cloverdale, Va., 12 miles, and it is expected that the line will now be rapidly built.

BALTIMORE & OHIO.—Work has been resumed on the line from Linden Station, Md., to Fairfax, W. Va., 25 miles, with a force of 100 men, and it is expected to have the line completed to the Potomac River by Jan. 1, 1893.

GEORGIA, CAROLINA & NORTHERN.—The contract for building the 8½-mile belt line by which this company will enter the city of Atlanta, Ga., has been let to the Southern Supply Co., of Birmingham, Ala. Work was begun on July 15, and is to be completed in 90 days. There will be two iron bridges of 125 ft. and 100 ft. span respectively. Res. Engr., W. P. Stalnaker, Atlanta.

ALTAMONT & MANCHESTER.—About 70 men are now at work on this railway between Altamont and Manchester, Ky., and five miles of the grading have been completed. From Manchester the line will run via Hyden and Whitesburg to Pound Gap, Va., about 100 miles. The route is through a partly mountainous country affording easy grades and curves. Pres., C. Crooke; Treas., A. M. Crooke; both of Altamont, Ky.

FLORIDA CENTRAL & PENINSULAR.—The local papers state that surveys are now in progress for a railway from Jacksonville, Fla., to Savannah, Ga., to connect this line with the South Bound, R. R., which it recently secured.

KENTUCKY MIDLAND.—Surveys are reported in progress for extensions of this railway from Frankfort, Ky., to a connection with the Louisville Southern R. R., 10 miles, and from Paris to Mt. Sterling, Ky., 28 miles.

Projects and Surveys.

MOBILE & DAUPHIN ISLAND.—The report is again in circulation that work will soon begin on this proposed railway from Mobile to Dauphin Island, Ala., about 25 miles.

NATCHEZ, COLUMBIA & MOBILE.—This recently incorporated company proposes to build a railway from Norfield to Columbia, Miss., 40 miles. Among the incorporators are F. W. Norwood and W. W. Butterfield, of Chicago, Ill.

Northwest.—Existing Roads.

LA SALLE & BUREAU COUNTY.—Secy., G. Weerts, of La Salle, Ill., writes us that this road will be finished and opened for traffic in about two months. It will run from La Salle, Ill., to the crossing of the Chicago & Northwestern and Chicago, Burlington & Quincy railways near Ladd, Bureau Co., Ill., 6¾ miles, and will do a freight business only. The contractors are McArthur Bros., of Chicago, Ill.

CHICAGO & EASTERN ILLINOIS.—Press dispatches state that it is the intention of this company to build its proposed extension from Terre Haute to Evansville, Ind., at once, and that the material for the new line will be on the ground by the middle of August.

CHICAGO & NORTHWESTERN.—Surveys are reported in progress for the proposed line from Moville to Sioux City, Iowa.

MILWAUKEE, LAKE SHORE & WESTERN.—This company is erecting a 3-span bridge 345 ft. long, with one 180-ft. swing span at Sheboygan, Wis., and a 2-span bridge 180 ft. long, with a 130-ft. swing span at New London, Wis. Contracts have also been let for four stone arch bridges of from 15 ft. to 20 ft. span, to replace trestle bridges between Bessemer, Mich., and Ashland, Wis.

WINONA & SOUTHWESTERN.—It is rumored that this company has surveyors in the field running a line from Osage to Mason City, Ia., 25 miles.

Projects and Surveys.

MINNESOTA & WISCONSIN.—Ch. Engr. R. E. Kirk, of Woodville, Wis., writes us that this company has absorbed the Woodville & Southern R. R. from Woodville, Wis., to Spring Valley, Wis., which has for some time been in operation as a lumber road, and has largely rebuilt the line, and is now constructing an extension from Woodville, Wis., north to Emerald, Wis. The principal business of the road will be in iron and lumber, the St. Croix Land & Lumber Co., being located at Wildwood, about five miles south of Woodville, and the smelters of the Eagle Iron Co., at Spring Valley. It is also intended to extend the line south to other iron mines and north from Emerald to timber lands and ultimately to St. Paul, Minn., via Stillwater. The section from Woodville to Emerald, Wis., now under contract is expected to be completed by Nov. 15. The work is about the average for this section of the

country; maximum grade, 40 ft. per mile, and maximum curve 3°. The contractor is Frank Jackson, of Hastings, Mich.

ANDREW, HURSTVILLE & SOUTHWESTERN.—Chartered in Iowa to build a railway from Andrew to Hurstville, Ia.

NEBRASKA CENTRAL.—The Fort Dodge, Ia., "Chronicle" says: "The Nebraska Central Co., by the terms of its contract with the city of Omaha, is bound to build 100 miles of road into Iowa, to tap either the coal regions of the northwest or of the southeast," said President Dumont to a "Chronicle" reporter. "Besides the $750,000 tax," he continued, "which Omaha has voted, they have also granted to the company the right of way through and across the streets of Omaha to South Omaha, to which they are to build a double track road to connect with the stock yard tracks, in addition to that they have the right of way up the Little Pappillion Valley, which is the natural approach to the city from the West and which roads coming into the city from that direction must use. The company will build a double track here also. Further, they have agreed to purchase depot grounds within three blocks of the post office building and build a union depot costing not less than $400,000 thereon. The depot grounds are an eighth by a quarter of a mile and will be the natural terminal of all roads centering in the city. There are two routes open in Iowa which the road may take. An eastern down through Warren County, and a northern up through Webster. Either of these would tap a good coal country, but the northern is the best because it would also furnish a route into the northern lumber regions. It is the intention to spend $2,000,000 for a road in Iowa and preliminary surveys are already started. Two corps of engineers are at work, one from this place toward Omaha, and one from Omaha toward this place. They expect to meet somewhere about Scranton. The bridge, union depot and terminal in Omaha will cost at least $5,000,000 additional. Work on the bridge at Omaha is to be begun the first of March, 1893, and completed within two years."

SIOUX CITY, CHICAGO & BALTIMORE.—This company, whose incorporation was noted in our issue of April 2, is petitioning for a special election at Sioux City, Ia., to vote on the granting of a tax in aid of the road. A surveying party has been at work on the preliminary line for some time and the surveys are now completed from Sioux City, Ia., east, via Anthon and Battle Creek, to a point in the southwestern part of Crawford Co., Ia. It is intended to complete the survey to Des Moines, Ia., this fall.

Southwest.—Existing Roads.

ULTIMA THULE, ARKADELPHIA & MISSISSIPPI RIVER.—The surveys have been completed for an extension of this railway from Dalark, Ark., via Fairview and Halley Springs, to Millville, Ark., 25 miles, and contracts for construction will be let about Sept. 1, 1892. Ch. Engr., N. S. Woods, Arkadelphia, Ark.

KANSAS CITY, NEVADA & FORT SMITH.—The contract has been let for extending this road from Hume, Mo., south 50 miles, the work to be completed in 60 days.

CHICAGO, ROCK ISLAND & TEXAS.—This company has been organized in Texas to build the extension of the Chicago, Rock Island & Pacific R. R., from the Indian Territory line, south to Bowie, Tex.

GALVESTON, LA PORTE & NORTHERN.—Work is making good progress on this road from La Porte to Harrisburg, Tex., 35 miles. The grading is now completed from La Porte to Clinton, Tex. Ch. Engr., C. G. Woodbridge, La Porte, Tex.

VELASCO TERMINAL.—An extension of this Texas railway from Chenango Junction to Leslie, Tex., is talked of, and it is stated that contracts for the grading will be let some time in August.

MISSOURI, KANSAS & TEXAS.—A press dispatch from Houston, Tex., says: "Messrs. Burkett & Burns, the contractors who were awarded the contract for the construction of the extension from Smithville to Lockhart, have begun work and will have it completed within the next 40 days. They have employed 150 teams and 200 men, and intend pushing things ahead at a rapid rate. Before completing this line they will commence the construction of the line from Boggy tank to Houston. The new line from here to San Marcos is an air line and will make connections which will place the road on the same footing as the Southern Pacific to San Antonio, the distance being about equal between the two cities over both roads. This completion will probably have the effect of lowering the time between these points."

Projects and Surveys.

ARANSAS HARBOR TERMINAL.—Chartered in Texas to build a railway from Aransas Harbor, Tex., to a point 9¾ miles distant on Mustang Island. Among the incorporators are: J. P. Nelson, Edgar Foster, Jas. P. Markham and others.

PINE BLUFF & EASTERN.—This company has been chartered in Arkansas to build a railway from Pine Bluff, Ark., east to a point at or near St. Charles, on the White River. It is stated that the road will operate in connection with the Pine Bluff, Monroe & New Orleans R. R. The incorporators are: F. M. Gillett, New York City; H. E. Martin, of Stuttgart, and John M. Taylor, A. V. Stafford and John O'Connell, of Pine Bluff, Ark.

Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—The 28 miles of the Chehalis-South Bend branch, beyond the present end of track, will be ready for the rails in 60 days.

LOS ANGELES TERMINAL.—This company has about completed the surveys for its proposed branch to Rubio Canyon.

COLUMBIA & PUGET SOUND.—This Washington company will let contracts in a few days for the extension of the Maple Valley line to Sherwood's granite quarry, six miles.

FLORENCE, CRIPPLE CREEK & STATE LINE.—The contract for building this road from Florence, Colo., to the Cripple Creek mines has been let to J. B. Orman & Co., of Pueblo, Colo. Pres., J. M. McCandless, Florence, Colo.

Projects and Surveys.

PORT GARDNER, LAKE STEVENS & EASTERN.—This company, whose incorporation was noted in our issue of July 14, proposes to build a railway from Everett, Wash., to Lake Stevens. The incorporators are: John F. Hart and J. M. Davis.

SIUSLAW & EASTERN.—It is expected that grading will soon begin on this railway from Siuslaw Harbor to Eugene, Ore., 50 miles. Ch. Engr., T. R. Berry, Eugene, Ore.

SAN FRANCISCO & SALT LAKE.—The books of this company will be opened for stock subscriptions soon and the projectors state that $3,000,000 of stock will be taken in San Francisco. The company was chartered some weeks ago to build a railway from San Francisco to Salt Lake City.

Foreign.

FERROCARRIL GRAN OESTE MEXICANO.—This company has been chartered in New Jersey to construct and operate railways and to improve and develop lands in Mexico. Incorporators: G. H. Huntington, D. Galvin, A. Price, G. S. Martin, of New York City, and E. F. Galvin, of Jersey City, N. J.

ELECTRIC RAILWAYS.

NEW HAVEN, CONN.—The New Haven & West Haven Street Ry. will substitute electric for horse traction.

PHILADELPHIA, PA.—Plans for the trolley line equipment of the Traction Co.'s line on Bainbridge St. have been prepared by the Electrical Bureau. The poles will be of iron 28 ft. long, 22 ft. 6 ins. above the pavement, and heavy guard wires will be used.

MONTREAL, QUE.—The contract for an electric railway has been granted to the Montreal Street Ry. Co., and work will be commenced shortly.

ELEVATED RAILWAY.

CHICAGO, ILL.—The Metropolitan Elevated Ry. Co. has made arrangements with the West Side Construction Co. to build its line, and it is stated that the $10,000,000 bonds have been taken by Lee & Higginson, of Boston; Clark, Dodge & Co., of New York, and other firms, including an English syndicate. Col. Wolcott is the principal promoter.

HORSE AND MOTOR RAILWAYS.

DILLSBURG, PA.—Dillsburg, York Springs & Gettysburg Street Ry. Co.; $150,000; Levi Lauck and John C. Comfort,

EAST ST. LOUIS, ILL.—St. Louis, Collinsville & Eastern Ry. Co.; $200,000; to operate a dummy line; Douglas H. Donovan, F. H. Rogers and Vincent H. Stiles.

LEAVENWORTH, KAN.—The Leavenworth Power Co. has been granted permission to build a line, operated by compressed air, through the grounds of the Soldiers Home.

HIGHWAYS.

MASSACHUSETTS.—A boulevard 110 ft. wide is proposed from Brockton to Whitman, at a cost of $21,000. Plans have been prepared by Mr. Torrey, of Brockton.

RHODE ISLAND.—The legislative committee appointed to inquire into the condition of highways throughout the state has decided to send out to the town clerks a circular containing a list of questions for information as to the extent and cost of roads, manner of construction, wages of labor, special laws, etc.

OHIO.—The County Commissioners of Lucas Co., at Toledo, O., will be petitioned at their August session to authorise the construction of a new county road.

BRIDGES, TUNNELS AND CANALS.

BOSTON, MASS.—Bids will be received until Aug. 1 for constructing the draw for the L St. bridge. It will have two roadways 19 ft. wide, and two 5½ ft. sidewalks, and will be 40 ft. long. Wm. Jackson, Cy. Engr.

ELIZABETH, PA.—A new bridge will be built at this place.

NEW CUMBERLAND, PA.—The prospects are good for the construction of a new bridge across the Susquehanna River.

INDIANAPOLIS, IND.—Bids will soon be asked for building an iron bridge over Pogue's Run at Washington St. It will cost about $25,000.

YANKTON, SO. DAK.—A bridge company has been organized to construct a bridge across the Missouri River, at this point, under the franchise recently granted by Congress.

OMAHA, NEB.—The plans for the 15th St. viaduct have been completed. It will be 1,100 ft. long, with a 50-ft. roadway and two 8-ft. sidewalks, and will cost about $150,000.

ST. JOSEPH, MO.—City Engr. Fanning has the plans and specifications nearly completed for the viaduct across the railway tracks at Sacramento St. It will have nine 60-ft. spans and two 45-ft. spans, and will be 20 ft above the tracks. The roadway will be 18 ft. wide, and there will be two sidewalks.

WATER-WORKS.

New England.

GREENVILLE, ME.—A gravity supply from Wilson Pond is talked of.

SOUTH BARRE, VT.—It is reported that pipe has been bought for a gravity supply for domestic use and to run a motor.

BETHEL, VT.—Engr. Joel Foster, it is reported, estimates that gravity works, with a reservoir, could be built for $8,000.

NEWTON, MASS.—The City Treasurer has been authorized to issue and sell $100,000 of 4% water loan bonds to mature in 1928.

ORANGE, MASS.—The contract for about ten miles of pipe has been awarded to the Warren Foundry & Machine Co., New York, and for pipe laying to Di Generi, Little & Long, of Boston. The contract for hydrants has been awarded to the Holyoke Hydrant & Iron Works.

WINTHROP, MASS.—Jas. R. O'Hara, Henry B. Fiske, and others were recently appointed at a town meeting to employ an engineer at an expense of $1,000 to report on an independent water supply. The Revere Water Co. now supplies this place and Revere.

NORFOLK, CONN.—The Wethersfield "Farmer" advocates the building of works here.

WINSTED, CONN.—The people have voted to have a special election to vote on a new supply.

Middle.

GENEVA, N. Y.—It is reported that a new pumping station will be erected on Seneca Lake.

HUNTINGTON, N. Y.—The Huntington Water Co. will issue $15,000 of stock and $25,000 of bonds.

NEWPORT, N. Y.—The people have called a special election to vote on issuing $10,000 of bonds to buy the Perry water system.

ENGLEWOOD, N. J.—It is reported that the Hackensack Water Co. has offered to begin at once to lay mains to supply the hill portion of the village, provided a yearly revenue of $4,000 is guaranteed.

OCEAN CITY, N. J.—The Ocean City Water Co. has been incorporated; $50,000.

WESTFIELD, N. J.—Bids for erecting a stand-pipe plant are wanted by the township. C. R. Clark, Clk.

DOYLESTOWN, PA.—The Borough Council has instructed the Water Committee to ascertain the cheapest and most feasible plan to increase the water supply.

McKEESPORT, PA.—Bids will be received until Aug. 2 for four horisontal flue boilers. E. Wolf, Secy. Water Dept.

WEST CHESTER, PA.—The Borough Surveyor has been ordered to survey reservoir sites.

CUMBERLAND, MD.—The Water Commissioners recommend a new pumping station with larger pumps and boilers, and larger mains. Hopewell Heff, Chn.; W. E. Griffith, Secy.

Southern.

ALLENDALE, S. C.—Works are projected with fair prospects of construction, it is said.

MONROE, LA.—The Monroe Water-Works & Light Co. has been formed by New Orleans parties; $125,000; Irwin Jamison, Pres.; L. E. Cenas, Sec. and Treas. An artesian well will be sunk under the direction of J. J. Jackson.

FLORA, MISS.—Small works are projected with a supply from a spring said to be about 1½ miles from and about 40 ft. above the village.

SHELBYVILLE, TENN.—Permission to secure a state charter for a water company has been granted by the city to Dr. J. E. Thompson and B. L. Ridley, Murfreesboro, and J. D. Hutton, Thompson Berry and others, Shelbyville.

North Central.

CANTON, O.—Secy. Paul Field wishes to know the prices of stand-pipe.

CINCINNATI, O.—July 20 the people voted 9,706 for and 20,266 against issuing $6,000,000 of bonds for new works.

CLEVELAND, O.—Bids are wanted until Aug. 3 for setting four tubular boilers and furnishing mechanical stokers or smoke preventing devices. R. R. Herrick, Dir. Pub. Wks.

MADISONVILLE, O.—The contract for pumping machinery has been awarded to the Laidlaw & Dunn Co., Cincinnati.

ANDERSON, IND.—The contract for the extensions has been awarded to Snyder & Williams, Dayton, O., for $20,728, and for the pumping station to L. B. Stephens, for $8,728.

NORTH MANCHESTER, IND.—The Council has ordered a special election to vote on the establishment of works.

PETOSKEY, MICH.—The people have voted $15,000 for improvements.

TECUMSEH, MICH.—Bids for building works are wanted, as stated in detail in our advertising columns.

CANTON, ILL.—It is reported that the supply must be increased.

DECATUR, ILL.—Filters are proposed. Mayor, W. B. Chambers.

LACON, ILL.—A contract for works has been let to the Smedley Manufacturing Co., Dubuque, for $8,100, including a pumping plant.

VENICE, ILL.—The village will receive bids until Oct. 7 for the purchase of its works and a 20-years' franchise. The works were built in 1889, and are small. Population in 1890, 932. J. A. Brammell, Pres.; L. A. Summers, Clk.

NEENAH, WIS.—Engr. Sturtevant is completing plans for village works, with a supply pumped from the lake to a stand-pipe.

NEW RICHMOND, IND.—Works are proposed. A well 100 ft. deep, owned by the village, is said to yield 200 gallons per minute.

Northwestern.

CHARTER OAK, IA.—The U. S. Windmill & Pump Co. have a contract to build small works at a cost of $3,932.

PELLA, IA.—Works are projected by private parties.

WOODBINE, IA.—Plans for works have been received and bids will probably be wanted soon.

SENECA, KAN.—Works are needed.

AUBURN, NEB.—The Council will be petitioned to call an election to vote on issuing bonds for works.

LEXINGTON, NEB.—Engr. A. A. Richardson informs us that bids for works estimated to cost $18,000 will be wanted until Aug. 15.

SYRACUSE, NEB.—Plans for $15,000 works are being made by F. L. Burrell, Fremont.

Southwestern.

AUSTIN, TEX.—Bids for penstocks, turbines and pipe are wanted, as stated in our advertising columns.

BELTON, TEX.—The Belton Well Co. has been incorporated to drill artesian wells, etc.; $10,000.

COLEMAN, TEX.—It is reported that works will be built.

ORANGE, TEX.—The Orange Ice, Light & Water-Works Co. has been incorporated; $60,000; L. Miller, P. B. Corry and others, Orange, and Ernest Pragst, New Orleans.

YOAKUM, TEX.—The Blanks Ice, Water & Power Co. has been incorporated; $60,000; Jim Blanks, Leonard Isaacs and O. J. Gorman. It is reported that a system of works are nearly completed.

Pacific.

GARFIELD, WASH.—It is reported that the Council has decided to build works, including a gravity supply from a 2,000,000-gallon reservoir, and about a mile of 8 to 3-in. mains.

TACOMA, WASH.—The Council has voted to take steps to introduce a gravity supply of water from the Mashel River. An engineer will be employed to make estimates preparatory to voting on the issuance of bonds.

FERNDALE, CAL.—R. S. Tyrell, H. A. Tyrell and Geo. E. Hanson have been granted a franchise.

ONTARIO, CAL.—The sum of $12,000 has been voted by the town to improve works for fire protection and irrigation.

RIVERSIDE, CAL.—The Riverside Water Co. has voted to issue $1,000,000 of bonds.

SANTA ROSA, CAL.—The Ukiah Water & Improvement Co. has been incorporated; $50,000; Directors, J. H. Brush, R. M. Swain and others.

LOGAN, UTAH.—Consult. Engr. Samuel Fortier, Ogden, has reported to the city on a new supply at an estimated cost of $30,635. This includes a reservoir, 8,063 ft. of 16-in. redwood conduit and 8,180 ft. of 10-in. pipe.

ARTESIAN WELLS.

AUSTIN, ILL.—The Town Board of Cicero has appointed a committee to arrange for the sinking of a well at a cost of not over $28,000.

IRRIGATION.

NEW COMPANIES.—Riverside Orchard & Irrigation Co., Glenwood Springs, Colo.; $250,000; H. W. Hallett, C. W. Darrow and others. Laguna Canal Co., Pueblo, Colo.; $200,000; to enlarge Lake Canal in Otero and Bent Cos. Walla Walla & Columbia Irrigation Co., Wallula, Wash.; $100,000. Lancaster Land & Water Co., Lancaster, Cal.; $100,000; Directors, George Okell, Lancaster; Geo. I. Cochran, Los Angeles, and others.

SEWERS.

BOSTON, MASS.—H. A. Carson, Ch. Engr. Metropolitan Sewerage Commission, states that bids will be opened Sept. 10 for a siphon under Shirley Gut in Boston harbor. The work will consist of two lines of 60-in. cast iron pipe to be furnished by the contractor.

MIDDLEBORO, MASS.—The citizens are considering the introduction of the Union system of sewage disposal by which the solids are separated from the liquids, grease is extracted, and the reserdue converted into a fertilizer, while the water is discharged purified.

SPRINGFIELD, MASS.—The contract for a sewer in Brightwood has been awarded to Mellen & McKenzie at $29,151.

WEST NEWTON, MASS.—The bids received July 12 for section 6 of the sewer system have been rejected, and the work will be readvertised.

HARTFORD, CONN.—A sewer is to be constructed to cost from $10,000 to $16,000.

BROOKLYN, N. Y.—The Department of City Works will receive bids until Aug. 4 and Aug. 8 for four sewers at each date.

GLENS FALLS, N. Y.—The lowest bid for the proposed sewer system was that of Benj. Van Vranken and Jas. Duell, Schenectady, $151,800.

HOOSICK FALLS, N. Y.—The Sewer Commissioners have decided to take immediate steps toward establishing a system of sewers. Jos. Buckley is President of the Board.

ILION, N. Y.—The surveys have been completed and specifications are now being prepared for the proposed system.

JAMESTOWN, N. Y.—The report for a sewerage system has been received. The recommendation for a main sewer includes 24,900 ft. of 12 to 24-in. vitrified pipe, 750 ft. of 15 to 24-in. cast iron pipe, 35 manholes; estimated cost, $60,000; for laterals, 108,255 ft. of 8 to 15-in. vitrified pipe, 105 flush tanks, 125 manholes; estimated cost, $72,500.

NEW YORK, N. Y.—Specifications have been ordered for an outlet sewer in Jerome Ave., from the Harlem River northward to Elliot St., 6,506 ft. Its largest section will be 8½ x 10 ft., and the work includes 17,000 cu. yds. of rock excav., 30,000 lin. ft. of piles, and 175,000 ft. of lumber.

ROCHESTER, N. Y.—The Commissioners appointed by the County Judge have reported that the proposed West Side sewer is a necessity.

ERIE, PA.—The Council has voted to issue bonds for an intercepting sewer.

LEBANON, PA.—The City Engineer will prepare plans for relief sewers.

WILMINGTON, DEL.—The City Engineer has been directed to prepare plans for sewers in Ward 9.

MACON, GA.—It is estimated that the proposed system of sewers in Vineville will require six miles of pipe and cost $12,000.

ST. JOSEPH, MICH.—The City Engineer reports that a sewerage system would cost about $47,000, not including laterals.

CHICAGO, ILL.—The proposed Wentworth Ave. sewer is expected to drain 5,500 acres and cost about $818,196.

JANESVILLE, WIS.—The plans prepared by C. F. Loweth, St. Paul, Minn., have been adopted.

SIOUX CITY, IA.—The Sewer Committee has voted to construct sewers in eight streets in Leeds.

TYNDALL, SO. DAK.—The City Auditor will receive bids until Aug. 1 for 3,721 ft. of sewer.

SENECA, KAN.—The City Council is discussing the sewerage problem.

WACO, TEX.—About 60,000 ft. of laterals will be laid, estimated to cost $30,000.

FAIRHAVEN, WASH.—The Council has ordered the construction of about a mile of additional sewers. About $50,000 worth of work is now under contract, and it is proposed to expend $100,000.

NEW WHATCOM, WASH.—The city has awarded contracts for 3,000 ft. of spiral steel sewer pipe to the Northwestern Supply Co., and 800 ft. to Durham, Curragan & Hayden; aggregate cost about $10,000.

PETERBORO, ONT.—The Council has decided to issue bonds for $40,000 to be expended in the initial steps for a system of sewerage.

MONTREAL, QUE.—The City Surveyor will receive bids until Aug. 3 for sewers in nine streets.

STREETS.

BROOKLYN, N. Y.—The Council has voted to repave five streets with asphalt.

FLUSHING, N. Y.—We are informed by G. A. Roullier, Cy. Engr., that the entire appropriation of $70,000 recently voted is for street work exclusively.

JAMESTOWN, N. Y.—The Board of Public Works is investigating asphalt pavements in other cities.

TROY, N. Y.—The appropriation for Watervliet arsenal includes $15,000 for paving Broadway.

MONONGAHELA CITY, PA.—Bids will be received until Aug. 1 for 9,900 sq. yds. of brick paving. Albert Smith, Engr.

BUCYRUS, O.—The lowest bids for two contracts were those of S. L. Hoover, Columbus, $22,846, and Frazer & Keil, $15,397.

DAYTON, O.—The Council has voted to pave six streets with Hayden block, Hallwood block, asphalt and brick. The estimates aggregate about $175,000.

MASSILLON, O.—The City Clerk will receive bids until Aug. 18 for paving East Main St. with brick.

PORTSMOUTH, O.—The City Clerk will receive bids until Aug. 16 for paving 16,028 sq. yds. with brick or blocks, 7,817 lin. ft. of straight curb, and 288 ft. of circular corners.

FORT WAYNE, IND.—The City Engineer will receive bids until Aug. 9 for ten contracts for grading and paving.

LA SALLE, ILL. The City Clerk will receive bids until Aug. 2 for 11,500 sq. yds. of double layer brick paving, and 2,910 lin. ft. of sandstone curbing.

LANSING, MICH.—E. Sellers, Cy. Engr., writes us that the city is constructing about 4 miles of sewers and grading between 5 and 6 miles of streets, and that it will probably construct about one mile of macadam pavement.

LITCHFIELD, ILL.—The Council has voted to pave certain streets at an estimated cost of over $30,000.

TORONTO, ONT.—A contract for concreting between the tracks has been awarded to Mr. Van Vlack, at $16,457. Contracts for paving with asphalt have been awarded the Trinidad company at $10,936, and Warren-Scharf Asphalt Paving Co., at $89,882.

ELECTRICAL.

HEMPSTEAD, N. Y.—We are informed by S. A. Smith, Pres. Trustees, that the contract for lighting the village has been awarded to the Ball Electric Light Co., New York.

PHILADELPHIA, PA.—The Edison Electric Light Co. is reported about to increase its stock $500,000 or $1,000,000 in order to enable it to meet the demands for electricity for power as well as for lighting. The company's station is in the heart of the business section, and there is almost as much demand for electricity for power purposes as for lighting. The chief uses of the current are for running elevators, printing presses and sewing machines. About 1,100 HP. is furnished daily for these uses, and there is a demand for more power.

MARTIN'S FERRY, O.—Bids will be received until Aug. 15 for an electric light plant. R. F. Allender, Cy. Clk.

LANSING, MICH.—We are informed by E. Sellers, Cy. Engr., that the city has voted to issue bonds for $60,000 for an electric light plant. The old plant will be purchased if a fair value can be decided upon, otherwise the city will erect a new plant. At present the city has 150 arc lights, Thomson-Houston, for which it pays $95 per year per light, the lights burning all night and every night. The city intends to enter upon commercial lighting. Chas. Connell is president and Daniel Barrianger secretary-superintendent of the consolidated Electric Light and Water Committee, having the matter in charge.

JEFFERSON CITY, MO.—Bids will be received until Aug. 10 for 30 or more arc lights of 2,000 c. p. each, the contract to be for 5, 8 or 10 years. Jas. E. McHenry, Cy. Clerk.

WEBSTER GROVES, MO.—The Suburban Electric Light Co. has secured contracts for over 1,100 lights and will erect poles and wires at once. It has contracted with the Municipal Electric Light Co., St. Louis, to furnish the electric currents.

SYDNEY, WASH.—The City Clerk will receive proposals for a municipal plant for electric lighting.

NEW COMPANIES.—Home Electric Concern of New Jersey, Newark, N. J.; $100,000; E. Ellery, Brooklyn, N. Y.; M. Rubens, New York, N. Y.; T. C. Barr, Orange. The Northwestern Light Co., Jersey City, N. J.; $10,000; C. E. Eckerson, Hackensack; G. H. Sullivan and C. M. Lewis, New York, N. Y.

CONTRACT PRICES.

SEWER.— Auburn, N. Y.—We are informed by R. J. Carson, Cy. Clk., that a contract has been awarded to Henry Ocobock, as follows: 42-in. brick sewer with 8-in. walls, 1,260 ft., $88.40 per lin. ft.; 26-in. with 4-in. walls, 1,835 ft., $54.60; 24-in., 273 ft., $38.27; 6-in. house connections, $10; standard conduits, $50 each; rock excavation, $3.50 per cu. yd.; masonry outfall, $200.

Knoxville, Tenn.—The prices of the sewer contracts which we noted last week as awarded to M. J. Condon & Co. at $180,632, are as follows: 38 x 57 ins. brick, $2.98 to $5 per ft., according to depth of cut, which ranges from 7 to 24 ft. for each size; 34 x 51 ins., $2.90 to $4; 32 x 48 ins., $2.85 to $4.50; 30 x 45 ins. $2.80 to $4; 28 x 42 ins., and 26 x 39 ins., $2 to $4; 24 x 36 ins., $1.93 to $3.50; 22 x 33 ins., $1.85 to $4; 20 x 30 ins., $1.80 to $4.45; 24-in clay pipe, $1.83 to $4; 21-in., 97 cts. to $3; 20-in., 91 cts. to $2.50; 18-in., 84 cts. to $2.50; 15-in., 65 cts. to $2; 12-in., 63 cts. to $1.50; 10-in., 60 cts. to $1.60; 8-in., 36 cts. to $1.50; iron pipe, 8, 10, 12, 15, 18, 20, 21, 24-in., $1.90, $1.95, $2, $2.25, $3, $3.45, $3.45, $4.25; 6-in. house connections, $1.40; manholes, $26.95; flush tanks, $57.95; piling, $1.25 per ft.; rock excav., $1.17; timber foundations, $75; concrete masonry, $7.50; brick masonry, $9.75; rubble masonry, $8.50; lampholes, $5; extra excav., $3.50; water supply pipe, $1.50. M. Nicholson is City Engineer.

STREET WORK.—Kansas City, Mo.—The Barber Asphalt Paving Co. has been awarded three contracts, 18,423 sq. yds., for paving with 2 ins. of asphalt on 6 ins. of concrete, at $2.65 per sq. yd., and one contract, 4,399 sq. yds., for 2½ ins. of asphalt, at $2.80. The streets are now paved with cedar blocks, which are to be removed and 4 ins. of concrete added to the present base. Other contracts were awarded for 493 sq. yds. granite blocks on 6 ins. concrete at $2.87½; 297 sq. yds. vitrified brick on concrete, $1.82; brick walks, 14¾ cts. per sq. ft.; curbing, 54 to 57 cts. per lin. ft.

Binghamton, N. Y.—Contract for paving Court St. with asphalt has been awarded to the Warren-Scharf Asphalt Paving Co., at $2.77 per sq. yd.

Hackensack, N. J.—A contract has been awarded to Patrick Byrne to furnish and lay 1,000 lin ft. of crosswalk stone 1-in. wide and 3 to 4 ins. thick, at 17½ and 23 cts. per ft. The New Jersey Traprock Co. was awarded a contract for 1,000 cu. yds. of 1½-in. stone and screenins, at $1.75 per cu. yd.

BRICK.—Washington, D. C.—The bids for paving brick ranged from $14 to $19.50 per M. for ordinary, and $17.65 to $22 per M. for re-pressed.

SAND.—Philadelphia, Pa.—Maj. C. W. Raymond has awarded the contract for 9,000 cu. yds. sand for the fort opposite Fort Delaware to Clement Reeves, Delaware City, Del., at 35 cts. per cu. yd. The contract for 12,000 cu. yds. for Pea Patch Island was awarded to the Atlas Dredging Co., Wilmington, Del., at 50 cts. per cu. yd.

MISCELLANEOUS.

NAVAL SUPPLIES.—Washington, D. C.—Bids will be received at the Bureau of Provisions and Clothing, Navy Dept., until Aug. 9, for lumber, steel, cement, etc., for the Portsmouth navy yard; tools, steel plates, brick, etc., for the Norfolk navy yard; two tubular boilers, cement, lumber, etc., for the League Island navy yard; and until Aug. 16, for steel plates, etc., for the Mare Island navy yard. Thos. J. Lasier, Acting Chief of Bureau.

BREAKWATER.—New York, N. Y.—Bids will be received until Aug. 26 for a breakwater, at New Haven, Conn. Col. D. C. Houston, U. S. Engineer's Office.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., are building a ten-wheel two cylinder compound engine for the Chicago & Northwestern. The Brooks Locomotive Works, Dunkirk, N. Y., have delivered a ten-wheel engine to the Toledo & Ohio Central, and are building 20 engines for the New York, Chicago & St. Louis. H. K. Porter & Co., Pittsburg, Pa., have built two engines for the Sabana railway in Colombia. The Union Pacific is building some ten-wheel engines at the shops at Omaha, Neb., for mountain service.

CARS.—The St. Charles Car Co., St. Charles, Mo., is building 10 passenger cars, 10 chair cars, 1,000 box cars and 500 coal cars for the Missouri Pacific, and 10 passenger cars for the St. Louis, Vandalia & Terre Haute. The Jackson & Sharp Co., Wilmington, Del., has completed 12 passenger cars, 8 excursion cars and 4 combination cars for the Staten Island Rapid Transit. Osgood, Bradley & Sons, Worcester, Mass., have an order for 70 passenger cars, $5,000 each, for the New York, New Haven & Hartford. The Barney & Smith Car Co., Dayton, O., is building 20 parlor cars for the New York, New Haven & Hartford. They will cost $7,000 each.

RAILS.—The Colorado Coal & Iron Co., Denver, Colo., has an order for 5,000 tons of steel rails for the Sante Fe & Prescott R. R., now being built in Arizona. They will be rolled at the works at Pueblo, which have a capacity of 250 tons per day.

SIGNAL WORKS.—The H. Wales Lines Co., Meriden, Conn., has the contract for the new works of the Hall Railway Signal Co., at Garwood, N. J. They will include a 3-story machine shop 100 x 40 ft., 1-story engine and boiler house 60 x 40 ft., 2-story wood-working shop 60 x 40, an office, and a chimney stack 85 ft. high. The contract price is about $30,000.

COMPANIES.—Neff Pneumatic Water-Works Co., Logansport, Ind.; Neff pneumatic force pump for house supply; $10,000; Pres., I. E. Kauffman, Goshen, Ind.; Gen. Man., C. E. Snively, Milford, Ind. St. Louis Paving Brick Co., St. Louis, Mo.; $250,000; the works will be at Collinsville, Ill.; Pres., D. V. Purington, Chicago; Vice-Pres., E. C. Sterling, St. Louis. Automatic Car & Air Brake Co., Madison, Ill.; $10,000; James B. Thomas, Murray Carleton and John P. Boogher. Duluth Pump Co., Duluth, Minn.; $60,000; Barnes' patent pump; Pres., C. W. Hoyt.

CURRENT PRICES.

RAILS.—New York: $30 at Eastern mills, $30.75 at tidewater; old rails, $20 for iron and $17 for steel. Pittsburg: $30; old rails, $20 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $17.50 to $18 for iron and $12.50 to $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.8 cts. for iron and steel; spikes 2.1 to 2.15 cts.; track bolts, 2.65 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57¼ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing 55 per cent.

FOUNDRY PIG IRON.—New York: $14 to $15.50. Pittsburg: $13.25 to $14.50; Chicago; $13.50 to $15.

LEAD.—New York: 4.1 cts. Chicago: 4.1 cts. St. Louis: 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.15 to 2.5 cts. for large lots, and 2.25 to 2.65 cts. for small lots, channels, 2.25 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.8 to 2.2 cts.; steel plates; 1.85 to 1.9 cts. for tank, 2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 1.9 to 1.95 cts. for large lots, and 2 to 2.05 cts. for small lots; channels, 1.9 to 1.95 for large lots, and 2 to 2.05 cts. for small lots; angles, 1.8 to 1.9 cts.; tees, 2.35 cts.; universal mill plates, 1.8 to 1.9 cts. for iron and steel; sheared steel bridge plates, 1.95 to 2.05 cts.; refined bars, 1.7 to 1.75 cts. for iron and steel; steel plates, 1.75 to 1.85 cts. for tank, 2 to 2.1 cts. for shell, 2 to 2.1 cts. for flange, 3.5 to 3.75 cts. for firebox. Chicago: beams, 2.1 to 2.05 cts. for large lots, and 2.15 to 2.25 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2.2 to 2.25 cts.; tees, 2.4 to 2.6 cts.; universal plates, 1.9 cts.; sheared steel plates, 2.25.; steel plates, 2.3 to 2.4 cts. for tank, 2.0 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.